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THE CHANGES IN THE BLOOD DURING THE FIRST TEN DAYS OF INFANT LIFE.

An Analysis of Eighteen Cases, with a review of the literature of the subject, and notes on the maternal blood.

by

H E N R Y   H.   R O B A R T S

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As House Surgeon in the Royal Maternity and Simpson Memorial Hospital, Edinburgh, I had ample opportunity of examining the blood of healthy full-time infants from the time of birth up to the tenth day, when the majority of the cases left the Hospital. The results of my examinations in eighteen infants form the main subject of this thesis.

The characteristic features of the newborn infant's blood have, for the last twenty-five years, been the objects of numerous investigations, and we have to thank German and French research very largely for our present knowledge of them. As early as 1830, however, Denis(1) drew attention to the fact that the erythrocytes were much more numerous during the first days of extra-uterine life than in the adult, and that blood taken from the Umbilical Artery had a specific gravity of 1075, and contained a relatively small amount of fibrin.

Nasse(2) in an article in Wagner's 'Handwörterbuch der Physiologie' gives an exhaustive sketch of what was known of the blood at that time, but makes no reference to the infant's blood beyond remarking that, for the first few days of life, the colour is a very dark red, and that, while the specific gravity of adult blood is 1055, that of the infant is 1045-1049.

A few years later numerous observations were made on the blood of new-born animals. In 1842 Andral, Gavaret & Delafond[(3)] studied the blood in lambs and found that during the first 24 hours after birth there was a comparatively small amount of fibrin present, but that in the course of the next four days the amount equalled that to be found in the adult-sheep.

Poggiale[(4)] came to the same conclusion in the case of puppies, and considered that the corpuscles were more numerous than in the adult, and that the iron was also in excess.

In 1852 Vierordt[(5)] conceived the idea of estimating the number of corpuscles in a small quantity of diluted blood, and by this method Welcker[(6)] two years later formed a scale of tints corresponding to blood containing a known number of corpuscles, and found in two new-born infants a count of 5,000,000 red corpuscles per c.mm. In one of these infants, dead born, by washing out all the blood from the vessels, he concluded that the total quantity of blood represented one nineteenth of the body weight. He considered that the severity of the labour had no effect on the blood of the infant.

In the same year Moleschott[7] estimated the proportion of the red to the white cells in a child two and a half years old, and found it to be 1 white cell to 133 red ones; in an adult, aged twenty-one, the ratio was 1 to 570; as he did not count the actual number of either the red or the white cells, he was not able to conclude that this difference was due to an increase in white corpuscles in the child, although he considered this probable.

In 1864 Panum[8] showed that the amount of solid constituents in the blood of new born puppies was much greater than in the mother's blood, and that it rapidly decreased during the first week. The specific gravity was 1053-1060 as compared with 1039 in the mother. From his observations he concluded that the new born animal's blood was richer in red corpuscles than the maternal, and that the foetus possessed a definite function for the formation of blood cells. Haematologists were astonished when, seven years later, Neumann[9] stated that he had found nucleated red cells in the heart blood of foetuses five and seven months old, and also in a dead born fulltime infant; he did not observe them in the case of a child sixteen days old.

Wiskemann[10] by spectral analysis estimated the amount of haemoglobin in four children, and obtained the following comparative results:-

Child	14	hours	old	1,343
"	8	days	"	1,265
"	10	"	"	1,303
"	14	"	"	1,163

His average for the healthy man was 1,075 and for the healthy woman 0,975. He thus demonstrated that the haemoglobin in infant blood far exceeded that found in the adult, and that during the first fortnight it rapidly decreased in quantity.

Thus, little by little, the chief peculiarities of the infant's blood were discovered, but no one had as yet studied the subject closely, and it was not until the later 'seventies' that it received any marked attention. From 1876-1880 many French observers (Guffer, Lépine, Dupérié, Bouchut & Dubrisay, Robin & Hélot) and a few Germans (Schücking, Leichtenstern, Arnheim & Demme) published their results, but the most important paper produced at this period was that by Hayem in 1877 'Des caractères anatomiques du sang chez le nouveau-né pendant les premiers jours de la vie.' Many German authors (Hofmeier, Haumeder, Mayer) endeavoured to estimate the total quantity of the blood in the infant.

In the next ten years, 1880-1890, papers appeared by Kruger, Widowitz, Bayer, Otto, and Silbermann, but still this department of haematology was far from being settled, and it is only during the last fifteen years that anything like a clear picture has been formed of the blood immediately after birth, and of the alterations which occur in the succeeding days, and of the causes for these. Since 1890 the most noteworthy contributions are those of Schiff, Gundobin, Fischl, Reider, Japha, Carstanjen and Perlin. In addition to these two papers containing original observations have been published in this country, the first by Elder & Hutchison in 1895, and the second by Aitken in 1902. Warfield's paper "Differential Leucocyte Counts in the Newborn" is the only original work from America that I have been able to discover. Ballantyne in his "Antenatal Pathology and Hygiene of the Foetus" quotes the work of several Italian authors - Bidone & Gardini, Ferroni, Varaldo and others - as being of special merit.

One would be inclined to think that with all this literature the characters of the infant's blood must now be well established, and to a certain degree this is true, but many of the results are still so varied and in part unsystematic that their value is much diminished. This disagreement in observations has its origin very largely in the fact that the human being in the first weeks of life reacts in a much more intense degree to internal and external influences than the adult individual, and thus the blood is subjected to greater fluctuations both in absolute amount and in its actual constituents. Many authors have drawn their conclusions from such a small number of cases that these fluctuations are very apparent, or they have omitted to give such important details as the age of the child, or the number of cases examined. Through omitting to pay attention to these facts many authors, too, have been inaccurately quoted by other writers, so that for this thesis I have myself verified the majority of my quotations; unfortunately I have been unable to read the original articles of such important observations as those of Leichtenstern, Cadet, Hélot and some others, these

I indicate in the bibliography by an asterisk (*).

In the eighteen infants which I examined I made 104 estimations of the red and white corpuscles, and of the haemoglobin, and 91 differential counts of the white cells. Owing to the emergencies of the Hospital I was prevented in many cases from examining the blood immediately after birth, only eight cases being examined within the first hour of life; of the remaining infants, in five I made my first count three hours, in one four hours, in two eight hours, in one twelve hours, and in one twenty-four hours after birth. Though I did not examine cases with reference to the so-called "digestion leucocytosis", I was careful that my examinations were carried out as nearly as possible at a corresponding hour in each case, and immediately before the infant's usual time for being put to the breast; in this way I avoided, as far as I could, fluctuations in my counts.

I employed the Thoma-Zeiss haemocytometer for estimating the number of red and white corpuscles, in the case of the red cells, counting eight of the large squares, and the whole sixteen in the case of the white. For the red cells, I used the usual diluting solution of sulphate of soda and acetic acid, and a dilution of 1 in 200, and for the white cells .3% acetic acid solution and a dilution of 1 in 20. To ensure the accuracy of the white cell counts, I repeated the process in each case, and if the two results differed to any marked degree, a third count was made, and the average of the three then taken as the ultimate result. I paid special attention to the fact that Newton's rings were always to be seen before carrying out the various counts, carelessness in this respect giving very erroneous results in the case of the erythrocytes.

For the estimation of the haemoglobin I used Gower's instrument, with this modification that the pipette was graduated for half the usual quantity of blood and the resulting percentage was doubled to give the true one in each case. This modification is very advantageous in the case of such young children, as it is often difficult to obtain enough blood to fill the entire pipette without using undue pressure on the foot, and also as the usual percentage tube is only graduated to 120 it has not a wide enough range for the high percentages of haemoglobin sometimes met with.

The infants were all healthy and full-time; during the ten days in only one case was Icterus neonatorum to be observed, and in no instance did any pathological condition intervene. The cord was tied as soon as the pulsation had ceased. The blood was in all cases taken from the big toe, which I found to be much more convenient than the thumb.

The counts were made in all cases on the second day and subsequently in the majority of the cases on the third or fourth, sixth or seventh and tenth days. The infants were weighed on the first, third, sixth and ninth days.

In order to compare the mother's blood with that of her infant, I made counts before delivery, and in those cases where a considerable interval elapsed between the time of the count and the delivery, I repeated the examination in the case of the white cells. The leucocytes were estimated during the puerperium, but I made no differential counts.

I shall discuss the literature of the subject along with my own results under the following five sections:-

1. Red blood corpuscles in the infant.
2. Haemoglobin in the infant.
3. White blood corpuscles in the infant.
4. Differential counts in the infant.
5. The maternal blood.

The Red Blood Corpuscles:

It is a well known fact that at the moment of birth the number of the erythrocytes per c.mm. is far in excess of the normal for adult life, but no average has as yet been given on a large number of cases which can be taken as a normal for the newborn child.

The first count in my own cases gives the following results:-

8	Cases	1	hour	after	birth,	average	5,683,750
5	"	3	"	"	"	"	5,922,000
1	"	4	"	"	"	"	6,240,000
2	"	8	"	"	"	"	6,045,000
1	"	12	"	"	"	"	5,270,000
1	"	24	"	"	"	"	5,490,000

The average for seventeen cases in which the red cells were counted within the first twelve hours and before the infant was put to the breast is 5,791,764. My lowest count was 5,040,000, in five cases was it over 6,000,000 and in one it was 7,210,000.

These results besides demonstrating the high initial count, suggest that an increase occurs very soon after birth, but the number of examinations during the later hours of the day are too few to permit of any definite conclusion from my own results. I shall discuss this apparent increase later.

In looking over the literature dealing with the red corpuscles, one comes to the conclusion that $5\frac{1}{2}$-6 million is about a normal average for the first day of extrauterine life.

In the following list of cases I use only those results which deal definitely with a stated number of cases examined shortly after birth. The results of Knoepfelmacher I have extracted from his paper on Icterus neonatorum, and those of Zangemeister & Meissl from work which they carried out when comparing the Liquor Amnii with the maternal and newborn infant's blood.

Hayem[11]	17 cases	5,368,000
Elder & Hutchison[12]	6 "	5,346,000
Knoepfelmacher[13]	10 "	6,315,000
Zangemeister & Meissl[14]	28 "	5,935,337
Perlin[15]	13 "	5,711,500
Aitken[16]	33 "	6,450,000

When to these results, which without exception, were made with Thoma-Zeiss' instrument, I add my 17 cases averaging 5,791,764 , the total number of cases examined within the first twelve hours is 124, giving an average of 5,953,399 red corpuscles per c.mm.

I exclude some observations from this table.

Schiff[17] in his first paper has an average of 6,031,428 for eight cases on the first day, but he does not state how soon after birth these examinations were made; in his second paper he gives in 26 cases an average of 7,291,918; in the light of the above table and his own previous average, such counts seem too high. Bayer[18] and Arnheim[19] found the extremely low averages of 4,410,000 and 4,250,000 respectively. The former results I had no opportunity of verifying, and the latter author does not mention the number of his cases, nor how soon after birth they were examined; for the same reason I exclude Demme's[20] average of 5,600,000. Bidone & Gardini[21] give 6½ million as their average. Kruger[22] in one case found a count of 6,120,000 on the first day, and Cadet (quoted by Hayem) gives an average of 5,696,000. Otto,[23] whose average is so often quoted to be 6,165,000 only examined two cases on the first day, and these had, 10 and 15 hours after birth, counts of 6,910,000 and 4,440,000. Sörensen's[24] average is given as 5,769,500, but I find it is derived from male infants five to eight days old; in female children one to fourteen days old, the count was 5,560,800. Bouchut & Dubrisay's[25] fifteen cases from 2½ to 15 days old average only 4,300,000.

The question at once suggests itself "Why is the new-born infant so richly supplied with red corpuscles?" Schiff in his first set of cases examined none immediately after birth, yet he throws doubt on the fact of a high initial count, and considers that there is a rapid increase up to the time of the first feeding due to the loss of fluid through perspiration and respiration causing a concentration in the blood. This, as will be seen later, is probably in part the cause of the rise in the count during the first three days, but can it possibly affect to such an extent the blood of an infant who has only breathed for an hour? I think not. The results in his second paper are evidence in favour of a high initial count for many of his cases have a count over 7,000,000 and two over 8,000,000 although the examination was made immediately after the birth of the infant.

The reason for this high count is not difficult to conjecture. If an adult dwelling at an abnormally high level above the sea requires an increased supply of red cells for the more rarefied atmosphere, how much more must the foetus dependent on its obtaining oxygen indirectly by means of the placental circulation, require a larger number of cells while in utero than it needs after birth, when it can derive its oxygen by the lungs. However slow the circulation may be in the placenta, the exchange of oxygen and carbonic acid must take place so much more slowly there than in the lungs, that to compensate for this the oxygen-carrying power of the foetal blood is increased.

It is possible that the nature of the labour may in a minor degree affect the blood and I have divided my cases into three classes:-

1. Easy labour	3	Cases,	5,480,000
2. Normal Labour	8	"	5,730,000
3. Laborious & Instrumental	7	"	5,953,000

The term "easy" labour indicates those cases in which the delivery occurred unaided within six hours from the onset of the pains; I include one breech case under the heading of "normal" labour as no interference was needed; labours of 24 hours or longer duration, and all instrumental labours and one severe transverse case compose the third class.

Cabot[26] states that "children born after a long hard labor , or delivered instrumentally after a long labor , show the highest counts", but I have not found actual cases in the work of any observers illustrating this fact. Between the averages of the first two classes there is a difference of 250,000 red cells per c.mm. and between the second two 223,000. We would expect therefore to find that the children of primiparous women have a higher count than is to be found in those of multiparae, and also that on an average there is a higher count in the better developed infants. That the latter cannot be proved by my cases will be seen in the next table which I give, and the increase is really so comparatively small that it may not be noticed in such a few cases.

If we now compare the average in the case of ten first born infants with the remaining eight, we see that in the former the average is 5,870,000 and in the latter 5,650,000, or a difference of 214,000 red cells per c.mm. Whether these results are only coincidences can only be proved or disproved by further observations. I am of opinion that a cause may be found in the fact that the contractions of the uterus and the passage of the child through the pelvis must have an effect on the child similar to that which exercise or massage has on the blood of the adult, this effect being naturally greater the severer the labour.

Cabot examined four men before and after a race, the average red cell count before was 5,041,600 and after it 5,500,360 - an increase of over 450,000 cells. Hayem on the other hand finds a diminution of the red cells in fatigue.

I shall have occasion to refer again to their subject when discussing the white corpuscles.

In the following table I have arranged my cases according to the weight of the infants at birth.

No. of Cases.	Weight in lbs.	Average of Red Blood Corpuscles.
2	$5\frac{3}{4}$ - 6	5,355,000
2	6 - $6\frac{1}{4}$	6,435,000
1	$6\frac{1}{4}$ - $6\frac{1}{2}$	5,510,000
2	$6\frac{1}{2}$ - 7	5,920,000
3	7 - $7\frac{1}{4}$	6,416,000
5	$7\frac{1}{2}$ - $7\frac{3}{4}$	5,502,000
1	8 - $8\frac{1}{2}$	5,490,000
2	9	5,385,000

The development of the infant does not seem, from these results, to have any marked effect on the number of the red cells; the smaller children have possibly a slightly higher count, but as my cases are so few, I do not think they show anything conclusive in this respect.

When a systematic examination of the red cells is made during the first week a more or less marked increase will be found to occur during the first three days, and this is then followed by a gradual decrease in the number of cells. All observers are not agreed as to the duration or dimensions of this rise, but all except Demme consider that it is generally to be noticed. In my own cases, I obtained the following results, which I have graphically represented in Chart 1. (p.61)

1st Day	17 Cases	Average	5,791,764
2nd "	18 "	"	6,062,500
3rd "	18 "	"	6,006,000
4th "	14 "	"	5,988,500
6th "	8 "	"	5,906,250
7th "	11 "	"	5,864,454
10th "	18 "	"	5,521,400

The increase in my cases is not well shown in this table, for on an average it amounts only to 250,000; it is fairly well maintained during the first week, and the count does not sink below the number present at birth, until after the seventh day. In only four cases was the second count lower than that made at birth, in six the highest count occurred on the second day, in six on the third, and in two on the fourth day; the increase in four cases was under half a million, in nine it was approximately a million cells, and in one the count rose on the third day two million above the initial estimation.

Several theories have been advanced as to the cause of this characteristic rise and fall in the number of red corpuscles.

Lépine[27] with his pupils Gerard and Schlemmer stated the count, obtained shortly after birth, to be between five and six million as a rule, and occasionally was higher; an increase then took place during the first day, and from the second to the eighth day a diminution of about one million. They pointed out that the decrease in body weight was accompanied by a rise in the number of red cells, that when the former after the second day began to increase, the number of the cells fell. These fluctuations they attributed to changes in the proportion of plasma in the blood, and thus early suggested the possibility of the change in the count being only a relative one, and not due to any special activity in cell production.

Hayem found the increase to be very variable in amount (100,000 to 600,000) and not always to be observed. He considered that it depended not only on the loss of fluid which the infant experienced

in consequence of the inanition of the first hours, but "également et surtout" on the production of new elements, and the more or less active resorption of lymph by the tissues. He divided the red cells into seven classes according to their dimensions, which varied from 3.25 μ to 10.25 μ. This variation in diameter was very striking. For the infant who developed normally, the fluctuations in the counts were quite independent of the variations in weight; they appeared to him to result from a formation of new cells - the number of cells being inversely proportioned to their diameter: an increase showed a greater number of the smaller varieties, a decrease, on the other hand, more of the larger elements.
In the course of the second week the count fell to about half a million below that at birth.

Fischl (28) quotes Dupérié as agreeing with Hayem in all the main points.

Schiff's first paper is not of so much assistance as his second in explaining the cause of these changes, as he had no opportunity of examining cases soon after birth. Cohnstein & Zuntz (29) by experiments in young animals found that the foetus which had breathed had a distinctly greater number of corpuscles per c.mm. than one which was still born, and they attributed this to the blood being more concentrated. Cameres[30] has proved that the new born infant loses considerably more fluid by perspiration during the first twenty-four hours after birth than in the following days, and Preyer[31] showed the same to be the case with respect to respiration. From these observations Schiff thought that an increase in the count was probable up to the time that the child received food for the first time, but that as this increase was due to a concentration of the blood, it was only a relative one. From the first day his average count gradually diminished, as most of his cases had already been fed before they came under observation; on the fourteenth day the average was 500,000 lower than on the first.

In his second paper Schiff gives his observations with reference to the effect on the blood produced by tying the umbilical cord immediately, or a few minutes after birth. Budin[32], Schücking[33], and many other observers have proved that from the moment of birth until the umbilical cord is ligatured, the infant by means of its own respiratory effects and by uterine contractions gains a considerable amount of the blood in the placenta. Examinations of the blood were carried out by Hayem, Hélot[34], and Porak[35] to determine whether infants who had gained this placental blood had a higher count than those who had been separated from the mother at the moment of birth. Hayem's figures for the former are 5,576,000 and for the latter 5,087,000; Hélot's are 5,983,347 and 5,080,000 respectively, both finding a higher count for the later ligatured cases. But as the child received at the same time a proportional amount of plasma from the placenta, it is difficult to understand why there should be this increase. Schiff, therefore, carried out a different method, both examinations being made in the same child by means of simply pinching the cord at the moment of birth, and then allowing the blood to flow through the vessels again until the cord was ultimately ligatured ten minutes later, and the blood was again taken for the count. By this method he was not able to find any appreciable difference in the seven cases he examined.

His further observations were directed to finding out what became of this "Reserve" or "Placental" blood which late ligatured cases gained, and whether in the course of the new few days the counts of the two classes of cases differed. For this purpose he had eight cases ligatured at the moment of birth, and eighteen ten minutes after birth.

Chart III.* shows the results which he obtained. The early ligatured cases showed no rise in the red cell count, the number of corpuscles decreasing from the first day. In all the other ones the increase was very marked, and as can be seen on the chart reached the maximum in some cases on the second, in others on the third, and in a third class on the fourth day. The increases varied in amount from 500,000 to 2,000,000 cells per c.mm. The early ligatured cases at the end of fourteen days were over a million cells under the count at birth, the later ligatured ones being from 200,000 to 500,000 under the initial count.

This increase in the late ligatured cases, Schiff considered to be too large to be accounted for by Hayem's theory of formation of new elements, and besides by this theory there should be a similar increase in the cases which were ligatured early. Schiff therefore advanced the theory that the excess of fluid in the later ligatured cases was excreted while the blood cells were retained; the blood therefore became more concentrated and a relative increase was found. In support of his theory he proved that the later ligatured cases excreted on an average

* p.63

24.8 c.c. more urine in the first three days than the early ligatured ones, and that the urine of the former contained relatively less solid constituents. As it is the usual rule in midwifery practice to wait for some minutes after the delivery before tying the cord, these observations of Schiff's are of special interest as probably accounting for the increase found in the erythrocyte count.

Of these three theories of Lépine, Hayem and Schiff, it may therefore be said, that though Lépine's was a mere hypothesis, his theory is really the key to Schiff's observations, that Hayem's cannot be held as sufficient to account for such great and rapid increases, but that Schiff's observations are the most complete and his theory is the probable solution of this remarkable feature of the blood changes.

Aitken's results on this point are very interesting. In fifteen cases examined at the moment at the moment of birth the average was 6,139,000, in thirty-three examined within the first hour 6,450,000 and in thirty-two counts made between twelve and twenty-four hours after birth, the average was 7,676,000. This increase as a rule continued during the second day, when he found in twenty-seven counts an average of 8,358,000 per c.mm. As I have shown from my own cases and those of Schiff, the maximum may occur on the second, third or fourth days, and therefore a general averaging of all cases examined tends to obscure this increase. This may be the case in Perlin's results in which the increase on the third day in thirteen cases is only half a million, the averages from the second, third and fourth days being almost identical. The amount of increase seems therefore to be very variable, being between several hundred thousand, and two million. This is only natural if Schiff's theory is correct as the increase depends firstly on the amount of blood which passes from the placenta to the infant, this in turn depending on the strength of the uterine contractions, and the size of the placenta, and secondly on the amount of fluid which the child excretes, and the amount which it absorbs.

So far we have only spoken of the increase of the first few days; we have now to consider the decrease which subsequently occurs.

The results obtained by Hayem, Schiff, Aitken, Perlin and those of my own cases are in agreement that by the tenth to the fourteenth day the count falls to about half a million below that at birth, so that towards the end of the second week a count of 5,500,000 is a fairly normal average. As a cause for this decrease Schiff suggests that the surplus in red cells is used up at first to supply the immediate necessities of the individual, and that this continues until a period is reached when the new method of nutrition is able to meet the infant's requirements. Gundobin[36] considers it to be due to the gradual approach of the new born organism to the physiological circumstances of the breast-fed infant;he thinks, however, to use his own words that "physiologische Bedingungen nicht genügend sind, um alle die beobachteten Abweichungen in der Zahl der rothen Körperchen im Blate des Kindes zu erklären." If he really means to suggest a pathological cause for some of these changes, his theory is surely not tenable, for one can hardly believe that a process which is essentially connected with a great physiological change, and is proved to occur in every infant, can be in any sense of the word pathological.

Hayem suggests that the fluctuations which occur from one day to another are dependent on a state of evolution. Though, as I have already shown, the increase is probably due to purely physical causes, this theory of evolution seems to be a very plausible one for the decrease in cells. It is generally accepted that in the last months of intrauterine life the liver and spleen play an important part in the formation of the red cells but that after birth this function is gradually relegated to the bone marrow, and therefore as their source of supply is so much lessened, the red corpuscles decrease. It is to be expected also that owing to the greater activity of the infant the red cells have now a shorter life.

In addition to these outstanding features in the fluctuations of the red corpuscles, Schiff has shown that daily changes in the count are also to be observed. In eleven cases he made seventy-four twice daily counts, and found in sixty-six of these the morning one was higher, and in eight the evening count; the difference was usually about half a million. Owing to the infant being more frequently fed during the day, he considered that the blood became gradually more diluted towards evening, and that during the night the infant excreted as much urine as by day, but received less fluid, so that the blood became gradually more concentrated. Aitken mentions the fact that he noticed a slight decrease in the number of corpuscles per c.mm. after the first feeding.

Since Lépine suggested in his paper a relation between the increase of the red corpuscles, and the decrease in weight, many authors, Hayem, Schiff, Gundobin and Aitken, have made reference to this question. Suffice it to say that the only relation to be found is that both are due to the loss of fluid being greater than the intake during the first days of life.

All authors agree that the red cell count is unaffected by the sex of the child.

The most marked features in the histology of the red corpuscles are the variety in the size of the cells, and the presence of erythroblasts.

The majority of the cells are of the same dimensions as in the adult, the smaller cells vary, roughly speaking, down to a diameter half the length of the normal cell's diameter, the larger ones, on the other hand, may attain the size of a polymorphous leucocyte. The extremes are rare. The larger forms very frequently show polychromatophilic changes, and poikilocytosis is more often to be noted in these than in the ordinary and smaller varieties. The "Schatten" or ghost cells described first by Ponfick and later by Silbermann[37] as occurring in the new born infant's blood, I have seen in several cases, and I am inclined to think that they are cells which have recently lost their nuclei.

In differentiating 1000 leucocytes, I noted at the same time in each slide the number of nucleated red cells present; in one case none were observed, in four none were seen after the second day, in two after the third day, in two after the sixth day, and in four after the seventh day; in the five remaining cases they were still present on the tenth day. The majority of the nucleated cells were normoblasts, occasionally a microblast was present, and four times I found megaloblasts; on three occasions I observed cells containing double nuclei. In two cases on the first day I counted just over a hundred nucleated red to one thousand leucocytes, and in three others I found them to be over twenty; after the first day they were very scanty, except in two cases in which I found fourteen and fourty-five on the second day. During the later days I frequently found free nuclei.

Hayem was the first to remark on the variety in size of the red corpuscles; his observations have already been mentioned. Gundobin, Hofmeier(38), Loos(39) and Aitken agree, but Fischl(40) does not consider the differences to be as marked as Hayem states. Silbermann found "Schatten" in all the sixty cases which he examined, and also in blood taken from the umbilical cord. Hofmeier observed that the corpuscles were of a more spherical shape than in adult blood, and that the tendency to rouleaux formation was less marked; this latter feature is denied by Fischl, and Aitken considers it to be inconstant.

Poikilocytosis and chromatophilia have been observed by Reider(41) and Loos, but Fischl considers that the former, as also the "Schatten" of Ponfick, to be artificially produced. As regards the nucleated cells, there is a great diversity of opinion. Neumann, who discovered them in the blood in 1871, found them to be much less frequent in the newborn than in the premature infant. Hayem denies their presence at birth. Reider found them in five out of seven cases on the first day, and in the only case in which he made regular differential counts they were still present on the fifth day. Loos and Fischl occasionally found a few, the latter considering them to be present only in children under 2000 grms. in weight and 40 cm. in length, and that even in the last two months of foetal life they were exceptional. Gundobin found them up to the fourth day and quotes Woino-Oransky as being in agreement.

Monti & Berggrün[42] found them in small numbers in two out of three cases, and Warfield also observed them, but considered that they disappeared in the first three days. Elder & Hutchison's results showed them to be as numerous as 1-20, to 1-8 of the white corpuscles; occasionally a free nucleus was observed, but no mitosis. They were present at birth in all the five cases examined by Carstanjen, and in two cases persisted until the third day. Hock & Schlesinger[43] reported them to be present in considerable numbers at birth, and to be occasionally found for some months after; mitosis was frequently seen by them. Karnizki[44] often found two or three nucleated cells up to the second, and occasionally as late as the eighth month. Aitken's results are very similar to my own; he says "In blood films from fourty different infants at birth, I found nucleated corpuscles present in all, but varying much in number. The highest count was 116 to 500 leucocytes, the lowest 1 in two coverglasses. In twenty-five films on the first and second day they were present in all but one. In twenty-seven differentiations, from the fifth to the ninth day, nucleated reds were present in twelve. They were found as late as the ninth day. The prevailing type is the normoblast; but when the number present is large, a few megaloblasts are usually present also."

The blood-platelets have in the newborn infant's blood been very little studied, Hayem, Cadet(45), and Detterman(46) being the only authors to mention them. From the results of Cadet's work in twenty-one cases Hayem writes that at birth they number 171,000 per c.mm., by the eighth day they have increased to 248,000, and on the eighteenth day they equal the number formed in adult blood - 400,000 per c.mm.

Detterman states that in the healthy adult they bear to the red corpuscles a ratio of 1 to 22, and that in the newborn they are distinctly fewer for the first three days, but gradually increase to the normal adult number.

The Haemoglobin:

In the following table I give the results which I obtained with Gower's Haemoglobinometer (see also Chart I. p.61).

1st day	17 Cases	116.5 per cent
2nd "	18 "	119.1 " "
3rd "	18 "	117.5 " "
4th "	14 "	117.8 " "
6th "	8 "	109.2 " "
7th "	11 "	111.1 " "
10th "	18 "	104.6 " "

In seven cases at birth the percentage was between 100 and 110, in five between 110 and 120, in three between 120 and 130, and in two it was as high as 132. On the tenth day the maximum was 116% the minimum 90%. The proportion of the haemoglobin to the red corpuscles varied very much in different individuals; one case with 120% haemoglobin had a count of 5,700,000, another with less haemoglobin (110%) had a higher count (6,100,000).

As is to be expected the rise and fall in the red cell count is reflected in the haemoglobin estimations, but the increase in haemoglobin is not so great, as is the case with the red corpuscles, and the subsequent decrease is more marked. This is well seen in Chart II. (p.62)

For the purpose of comparing the changes in the red and white corpuscle counts and the haemoglobin percentages, I have represented the initial result in each case as 100, so that each series of estimations starts from the same point; from this first estimation as 100 I have calculated the percentage proportion of the subsequent alterations, so that one can compare at a glance the course which the different elements and the haemoglobin take from day to day. In the same way Chart VII.* represents the changes in the differential count. Charts constructed after this method are naturally purely diagramatic and are here named 'Comparison Charts'.

Opinions differ very widely as to the amount of haemoglobin in the newborn infant. Hayem's average at birth is 110%, the percentage occasionally rising as high as 130. Leichtenstern[47] states that the newborn infant has 30% more haemoglobin than the adult, and that there is an increase on the second day. Schiff's average in eight cases on the first day is 104.6%, and by the tenth this fell to 96% and 90.8% four days later. Gundobin found 95-115% at birth; Elder & Hutchison 105.6%; Bidone & Gardini 120%; Aitken 106% in twenty-one cases. In Carstanjen's five cases the average for the first day is 113% (max.120%), on the twelfth day 106%. Perlin's average for eleven cases is 118% for the first day, 116% for the second, and 119% for the third, and from the third to the tenth day is a gradual fall to 110%. Tietzes (quoted by Fischl)

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* p. 67

used a Fleischl instrument graduated to 125, and in three out of five cases he found an amount which exceeded 125%. Reider in seven cases examined within the first twenty-four hours found an average of 128%, and Schiff in his paper on the specific gravity of the foetal blood reports two cases with 152% and 138% at birth. It is difficult to draw any conclusion from such varied results - an average of about 105% receives the support of Schiff, Elder & Hutchison, and Aitken, but the majority of observers find a percentage varying from 115 to 120 or over.

The cause for this high percentage at birth is presumably as in the case of the high red cell count to enable the foetus to obtain sufficient oxygen in utero; the increase and decrease is naturally due to the same causes which affected the red corpuscles. It is probable that the individual cell is richer in haemoglobin than in normal blood, and Schiff suggests as a reason for the haemoglobin decreasing more rapidly than the red corpuscles, that it is the older cells which are specially rich in haemoglobin, and that these disappear first from the blood. Without more evidence in its favour, this is a very doubtful hypothesis. He found that frequently in the same infant while the red cell count was higher in the morning than in the evening, the reverse was the case with the haemoglobin percentage; he gives no explanation for this phenomenon.

The White Corpuscles:

My average in seventeen infants examined within the first twelve hours after birth, and before being fed, is 22,098; they are tabulated here according to the time after birth at which the examination was made.

8 Cases	1 hour after birth	Average 19,028
5 "	3 hours " "	" 26,250
1 Case	4 " " "	" 16,200
2 Cases	8 " " "	" 26,200
1 "	12 " " "	" 17,200

One case was not examined until twenty-four hours after birth, and had then a count of 29,000.

I have been able to collect the following eighty-six cases which were with certainty examined within the first hour of birth:-

Gundobin	6 Cases	19,600
Reider	4 "	20,925
Elder & Hutchison	12 "	17,884
Schiff (2nd paper)	12 "	17,025
Zangemeister & Meissl	18 "	19,070
Von Seipiades(48)	8 "	19,268
Aitken	18 "	19,055
My own cases	8 "	19,028

These eighty-six cases have an average of 18,753.

It will be found, however, that the count of the white corpuscles at birth varies much more widely than is the case with the red cells; Elder & Hutchison's results vary from 12,200 to 26,500; Schiff's from 12,700 to 30,900; Zangemeister & Meissl's from 11,930 to 26,050; Aitken's maximum is 23,000 and minimum 16,400; my lowest count is 12,000, and highest 36,900.

Hayem found for the first forty-eight hours an average of 18,000; Otto in three cases, ten to twenty-five hours old, found an average of 23,300. The cases given by Schiff in his first paper were mostly examined late on the first day, and their counts ranged from 24,000 to 36,000. Woino-Oransky(49) found a count of 16,980 immediately after birth, 20,980 twelve hours later, and 31,680 on the second day. Perlin's thirteen cases examined on the first day average 17,146.

No satisfactory explanation has been suggested for this high count at birth, nor for the wide individual variations. I am of opinion that the nature of the labour has a marked effect, but it is possibly not a complete explanation, for in one case in which the labour was quite normal and only lasted twelve hours, with a very short second stage, the initial count was 31,250. In my seventeen cases examined within the first twelve hours and before the first feeding the three cases of 'easy' labour have an average of 14,740, in the eight 'normal' labours it is 21,930, and in the six cases of laborious or instrumental labours it is 26,000.

I would here again suggest that this increase is analogous to that occurring after exercise. The case in which I obtained the high count of 36,900 cells per c.mm. is very significant. It was one of transverse presentation; the infant was very well developed and gave considerable difficulty in its delivery, with the result that half-an-hour of artificial respiration and hot and cold water bathing was required to save it. I attribute the high count partly to the severity of the labour, and also to the subsequent treatment. There is only a difference of about 700 between the averages of the nine first born, and the eight other cases. The influence of the development of the infant on the white cells is no more evident than in the case of the red corpuscles.

The average of my eighteen cases during the first ten days is as follows (see also Chart I. and II.):-

1st day	17 Cases	22,098
2nd "	18 "	16,510
3rd "	18 "	12,561
4th "	14 "	11,757
6th "	8 "	12,043
7th "	11 "	11,177
10th "	18 "	11,811

A very appreciable fall was observed on the second day in the majority of my cases, and in only four was the second count higher than that of the first day. I made no special count with reference to the question of digestion leucocytosis but all counts after the first were made immediately before the infant was put to the breast.

Schiff's and Aitken's results are strong evidence in favour of there being a specially high leucocytosis after the first food; the latter made special observations on this point, and found in thirteen cases an average increase of 10,000 after the first feeding, the maximum being 17,000 and the minimum 5,000, subsequent feedings were followed by a distinct but lower leucocytosis. Gundobin's experience supports this in so far as the first feeding is concerned, and says that the longer the fast is, the sharper the increase, but that in most cases the increase in infants is only small (2-4000) and does not occur until five hours after the taking of food. Demme showed that artificial feeding was followed by a higher leucocytosis than when the infant was nursed by the mother.

Japha(50) and Moro(51) throw doubt on such a phenomena as "digestion leucocytosis", the latter finding in fact a diminution for some hours after food, and then a gradual rise to the original number at the end of four hours.

The count according to Hayem falls suddenly to 6,000 or even as low as 4,000 on the third day, when the infant reaches its minimum weight, and as the weight increases the count rises to 7,000 or 9,000. Dupérie's results were similar to Hayem's but no other authors have remarked this peculiar variation.

Daily fluctuations were observed by Schiff; his average from the fourth to the eighteenth day he gives as 12-13000.

Schiff and Von Scipiades found a slight rise at the time the cord falls off. Perlin's cases show an insignificant rise of 700 per c.mm. on the second day and after this a gradual fall to 10,970 on the tenth.

The question as to whether this increase is actually due to the first feeding or not cannot be considered as settled. The loss of fluid must in some measure account for a relative rise in the number of corpuscles, but this is cloaked by the sudden fall in the total number of cells. The rapid disappearance of this high leucocytosis at birth is analagous to the fall in inflammatory leucocytosis, when the cause is removed; if the leucocytosis is due to the birth, it will naturally disappear soon after.

There is a general consensus of opinion that by the tenth or eleventh day the leucocytes reach a level (10,000-12,000) which may be accepted as normal for the first months of infant life.

Why infants should require this high number of leucocytes is another problem which has yet to be solved.

Differential counts of the white corpuscles.

For the majority of my slides I employed Jenner's combination of Eosin and Methylene-Blue, but a few of the earlier cases were stained by Leishman's method. The counts were made with a moveable stage, and Zeiss' 1/12 oil immersion lens; in each preparation 1000 leucocytes were differentiated. I divided the cells into the following classes:-

1. The ordinary polymorphonuclear neutrophiles.

2. The large and small lymphocytes.
   Owing to there being no satisfactory standard for distinguishing these two varieties, I did not consider it to be advantageous to separate them.

3. Large mononuclear lymphocytes.
   Under this class I include those lymphocytes characterised by their large faintly-stained, round or oval nucleus, and by the relatively broad margin of faintly stained protoplasm.

4. Transitional Cells.
   Those cells which have very similar staining properties to the above class, but have a more or less deeply indented nucleus.

5. Eosinophiles.

6. Mast Cells.
   Large cells with a faintly stained polymorphous nucleus, and large dark blue stained granules.

7. Myelocytes.

On page 68 is a table giving the averages of the differentiation in the eighteen cases, and under each case (pp. 71 - 78) will be found the individual percentages and absolute counts.

I have been particularly struck while working out these "percentage" and "absolute" tables, of the special importance of the latter. Gundobin and Reider are the only writers who state their results after this method. Carstanjen's cases would have been of greater value had he too followed this plan, but he gives neither the total count of leucocytes per c.mm. nor the absolute differential counts. By failing to observe the changes in the absolute differential count, one is apt to conclude that a rise in the percentage of one variety of cell is due to an absolute increase; as however there is a great fall in the total number of white corpuscles due, as will be seen, to a rapid disappearance of the neutrophiles, the other varieties in consequence have a higher percentage value, but are in reality no more numerous per c.mm. Through this omission Carstanjen's conclusion that the fall in the neutrophiles is accompanied shortly after birth by a rise in the number of lymphocytes is erroneous. A comparison of the three charts IV., V. and VI. will show the similarity between the percentages in Carstanjen's six cases and my eighteen, and how widely the chart of the absolute counts differ from that of the percentage ones.

Polymorphonuclear leucocytes.

From the first day these cells diminish both absolutely and relatively, until on the tenth day a slight rise occurs. The difference between the first and the second day is only 1%, but corresponds to an absolute decrease of 4,000 cells; on the third day there is a marked absolute and relative fall, and from here until the seventh day it is more gradual. The total diminution in the number of neutrophiles is approximately 11,000. One thousand cells per c.mm. represents the rise found on the tenth day. As regards the individual cases the highest percentage on the first day was 76.2, and the lowest 43.9, while on the tenth day there were 50.6 and 24.

Small and Large Lymphocytes.

The advantage of the absolute differentiations is here very evident. Though these cells show an uninterrupted rise from 20.8% on the first day to 49.3% on the tenth, the absolute count falls 25% during the first three days, and not until the sixth day does the number exceed that of the first day.

From the sixth to the tenth day there is a sharp rise. The highest percentage on the first day is 40 and the lowest 11.6; on the tenth day the maximum is 60.5 and the minimum 30.5.

Large Mononuclear Lymphocytes.

The percentage of these cells is 2.1 on the first day and 1.9 on the tenth; in the interval it fluctuates irregularly between 1 and 2.5. The absolute counts show these cells to be most numerous on the first day - 469 per c.mm., and half this number on the tenth.

Transitionals.

These cells increase relatively from 9.2% to 13.8% during the first four days, and then diminish to 10.9% on the tenth day. They are most numerous on the first day, and after a considerable fall on the second day, they vary very little in their absolute number.

Eosinophiles.

There is a relative increase from 2.4% to 5.2% during the first six days , followed by a decrease to 3.6%. The absolute number varies very little, and on the sixth day, the total of 634 per c.mm. is only 100 above the number present on the first day. The individual variations are very marked, in three cases the percentages rising to 9, 10 and 13.2.

Mast cells.

Very small numbers are to be seen but these cells are very constant. They are rather more numerous at birth than during the succeeding days.

Myelocytes.

Myelocytes were present in eight cases on the first day but in very small numbers - .1%; on the third day I found them in two cases, and did not observe any in the later films.

The literature on the differential counts of the white corpuscles in the newborn is very scanty, the only good work being that by Carstanjen, and even he does not give details from which the reader can gather the real changes in number of the various forms of leucocytes. His results are very similar to my own. The polymorphs are immediately after birth far in excess of the lymphocytes, the former being 73.4%, the latter 16%, but by the ninth day the latter are 41.86% and the former 36.1%. There is a slight rise in the percentage of the polymorphs on the twelfth day. The transitional cells show a large relative increase from 8.4% on the first day to 18.6 on the ninth; the large mononuclears are in very small numbers .17% at birth, the highest value being .75% on the sixth day. Eosinophiles have a percentage of 1.9 at birth, and rise to 4.81% by the sixth day. He found in his films irregular masses of blue stained substance, which were more frequent from the second to the sixth day and he suggests that these are composed of the debris (or 'Zerfall') of leucocytes destroyed in the blood stream, and so more numerous while the polymorphs are rapidly decreasing. I have not been able to find these masses as a regular feature, and consider them to be artificially produced by stain precipitate and broken leucocytes.

Reider in five cases examined on the first day, two within the first hour after birth, found the polymorphs to average 74.2%, and the lymphocytes 23%; the eosinophiles he considered to be more numerous than in adult blood, 2.5% at birth, and in one case 6.2% on the fourth day. From the absolute results, which he gives in one case, the lymphocytes diminished in number for the first three days, whereas the percentage value steadily rose. Gundobin's six cases have 63% of polymorphs at birth; on the second day they rise to 70%, and then falls to 34.6%

in the infant two weeks old. The lymphocytes which are 25% at birth, decrease slightly on the second day, and then gradually increase to exceed the polymorphs on the fourteenth day; he, too, finds that the absolute number of lymphocytes decreases for the first five days, but is markedly increased by the second week.

Fischl in four cases, Warfield[52] in ten and Elder & Hutchison in twelve found the polymorphs in every instance to be much more numerous than the lymphocytes at birth. In opposition Hayem, Luzet[53] and Aitken state that at birth the lymphocytes are in excess of the polymorphs; Hayem, however, made no differential counts but merely makes this assertion from observations of diluted blood examined on the warm stage; Luzet used dried unstained films. Aitken's figures for fourteen cases at birth are lymphocytes 46-66%, neutrophiles 27.46%; in every case but one where the varieties were practically equal, the lymphocyte percentage was higher than the neutrophiles; after the first food the polymorphs in seven cases were 59%, the lymphocytes 36%. These remarkable results received no support beyond that of Hayem and Luzet, neither of whom had the advantage of examining stained preparations. Aitken's statements as to other authors having found the same results are quite inaccurate; he asserts that

Gundobin's results agree with his, which I have already shown is not the case, and he also says that "Loos and others hold that they (the lymphocytes) exceed the neutrophiles at birth". On referring to Loos' article[39], I find that he merely speaks in this respect of the blood in infancy, "das erste Kindesalter," and makes no special allusions to the conditions at birth, and besides Loos made no observations himself in the newborn, but simply quotes other authorities.

As regards "other"authors supporting Aitken's views, I have not been able to find any.

I hold it then as clearly established that at birth they polymorphs are more numerous than the lymphocytes. The frequency of eosinophic cells has been the subject of much discussion, Reider & Muller[54], Hock & Schlesinger, Aitken, and Kassowitz[55] considering these cells to be more frequent than in the adult, while Elder & Hutchison, Weiss[56], and Carstanjen are of opinion that there is very little difference in the two ages. Warfield and Loos found the number to vary very widely in babies of the same age. My own results indicate that the apparent infrequency at birth is due to the great predominance of the neutrophiles, but that in absolute number there are almost as many present at birth as at any other time; any patholgoical leucocytosis obscures the eosinophiles in the same manner. From day to day these cells vary on an average very little in their total per c.mm., but some infants show an unusually high number from the moment of birth. I have never observed them to be as high as 'several thousands' (Hock & Schlesinger); in one case they reached 1900, and one other infant had just over a thousand per c.mm.

Myelocytes were seen by Zelenski & Cybulski[57] shortly after birth; Fischl did not find any.

The changes therefore in the number of white corpuscles are almost entirely due to the decrease of the polymorphs; though their number may increase after the first food it soon falls, and by the end of the second day the decrease is marked. The lymphocytes, according to Gundobin and Reider, and as shown in my own cases, also take a small share in this decrease until the third or fourth day, after which they increase. An analysis of my differential counts supports my view that the labour has much to do with the high leucocyte count at birth and with the preponderance of the polymorph at that time. In the three cases of 'easy' labour, the polymorphs are 50.3%, the lymphocytes 34.4%, and other transitionals 6.5%;in the eight normal labours, the percentages are 66.8, 18.7 and 8.8 respectively; and in the six cases of severe labour examined within the first twelve hours the polymorphs are 66.2%, the lymphocytes 16.7%, and the transitionals 11.4%. Thus it appears that the easier the labour, the nearer do the number of polymorphs and lymphocytes approximate to each other. The 'severe' labour cases have a slightly lower percentage of polymorphs than the normal cases, because they have a larger number of transitional cells. It would be of great interest to ascertain the percentages in the blood of infants delivered by Caesarean Section.

The relation of the various forms of leucocyte shows no dependence on the development of the infant at birth, but the decrease and increase of the lymphocytes appears to follow closely the changes in weight of the infant.

It is possible that this fall in the number of the lymphocytes is due to the change in the method of the infant's nutrition, and that, as the child becomes accustomed to the new digestive processes, and gains in weight, these cells increase.

In his Goulstonian Lectures, Hutchison[(58)] is in favour of the view that there is a close connection between these cells, and the absorption of food, especially as regards the absorption of fat; if this view is correct it follows that the lymphocytes must play an important part in digestion during infancy, but the lymphocytosis of infancy cannot be satisfactorily explained, until the function of the lymphocytes is proved.

The Maternal Blood.

In the eighteen cases, the maternal blood had an average of 4,386,111 red corpuscles, 74.2% haemoglobin and 17,138 white corpuscles. The red cells were frequently as much as one and a half million under the number present in the offspring, in one case the two counts were practically equal, and in one the mother had 440,000 more red cells per c.mm. than the infant. The average difference was 1,405,000.

The average in seven married women was 4,597,142 red cells, and 75.4% haemoglobin, and in eleven unmarried patients 4,251,818 red cells, and 73.4% haemoglobin. The difference is but slight and is probably due to the unfavourable circumstances of pregnancy in the latter class.

It has been suggested that the mothers of male infants have a higher red cell count than the mothers of female infants. I found that in ten male births the mother's average was 4,637,000 red cells, and in the other eight cases it was 4,072,500; the haemoglobin estimations, however, were 70.8% for the former class, and 78.5% for the latter.

In eleven cases I made two examinations of the white corpuscles before delivery, the first being four to eight hours, and the second about one hour before delivery; the average for the first count was 14,643, and for the second 17,790.

The leucocytosis is, therefore, in most cases a moderately high one, and a considerable increase occurs in the last few hours.

Classifying my results according to the nature of the labour, I find that the cases of 'easy' labour have a count of 10,275, the normal cases 17,950, and in the laborious and instrumental labours there is an average of 18,457. In ten primparae the average is 18,900, and in eight multiparae 15.612.

The nature of the labour, therefore, has a marked affect on the degree of leucocytosis.

In the following table I state the averages of the white cells during the puerperium:-

2nd day	13 Cases	14,848
3rd "	12 "	15,316
4th "	9 "	13,900
6th "	5 "	13,090
7th "	12 "	9,600
10th "	17 "	9,978

I made no differential count in these cases, nor do I propose to discuss the literature on the maternal blood changes, but would merely say that my observations correspond with those which Cabot has collaborated from various sources.

In comparing the maternal and infant blood Elder & Hutchison found that the infant's blood was always richer in red corpuscles and haemoglobin than the mother's, there was nearly always a difference of at least one million red cells, and the haemoglobin was on an average 33.6% higher in the infant's blood. They state that when the infant's blood was below normal, there was a corresponding poverty in the maternal; my cases do not show this variation. Carstanjen's estimations of the haemoglobin in the mother were in the majority of cases but little over 50%, the infants having an average of 113%.

According to Bidone & Gardini's results the infant possesses 2½ million red cells, and 35-65% haemoglobin more than the mother.

Two observers found results widely different from the above. By estimating the amount of iron in the blood, Kruger concluded that the haemoglobin was about equal in mother and child. Scherenziss(59) states that the infant is poorer in haemoglobin than the mother.

After a careful examination of a good number of cases, and from the experience of many observers, one is compelled to acknowledge that no accurate picture can be drawn which will give a clear idea of what may be taken to be normal blood at birth. The blood of two equally healthy, equally well-developed newborn infants can differ so widely that whatever figures may be accepted as normal, many cases will come short of or exceed them.

Six million red corpuscles, and 18,000 white cells per c.mm., with 115-120% of haemoglobin may be accepted as a fairly good representation of the blood at the moment of birth. A moderate increase in the red cells is to be expected from the second to the fourth day, after which a gradual fall to 5,500,000 in the second week. The initial leucocyte count may be found to be higher after a severe labour. In some cases there may be an increase of the white corpuscles towards the end of the first day due to the first food, on the second day rapid decrease will take place in all cases, and by the middle of the second week, the number will be about 12,000 - a fair normal for the first months of infant life. The haemoglobin also will rise and fall in amount, and by the tenth day be from 95-105%. The large number of neutrophiles will be found to be the cause of the leucocytosis, but this will rapidly decrease and the lymphocytes after a slight decrease for three days will as a rule exceed the polymorphs by the end of the first week.

In the majority of cases nucleated red cells will be found at birth, and these cells may still be present for some time after.

By the tenth day the normal differential count for the first months of life is reached:-

Neutrophiles	30-40%
Lymphocytes	45-55%
Large Mononuclears	1.5-2%
Transitionals	10-15%
Eosinophiles	2.5-4%
Myelocytes	.2-.5%

In conclusion I would like to express my gratitude to Dr Ballantyne for permission to utilise this material for my thesis, and for his kindly encouragement, and also to Professor Czerny of the Kinder Klinik, Breslau, for allowing me to make such full use of the library of the Klinik.

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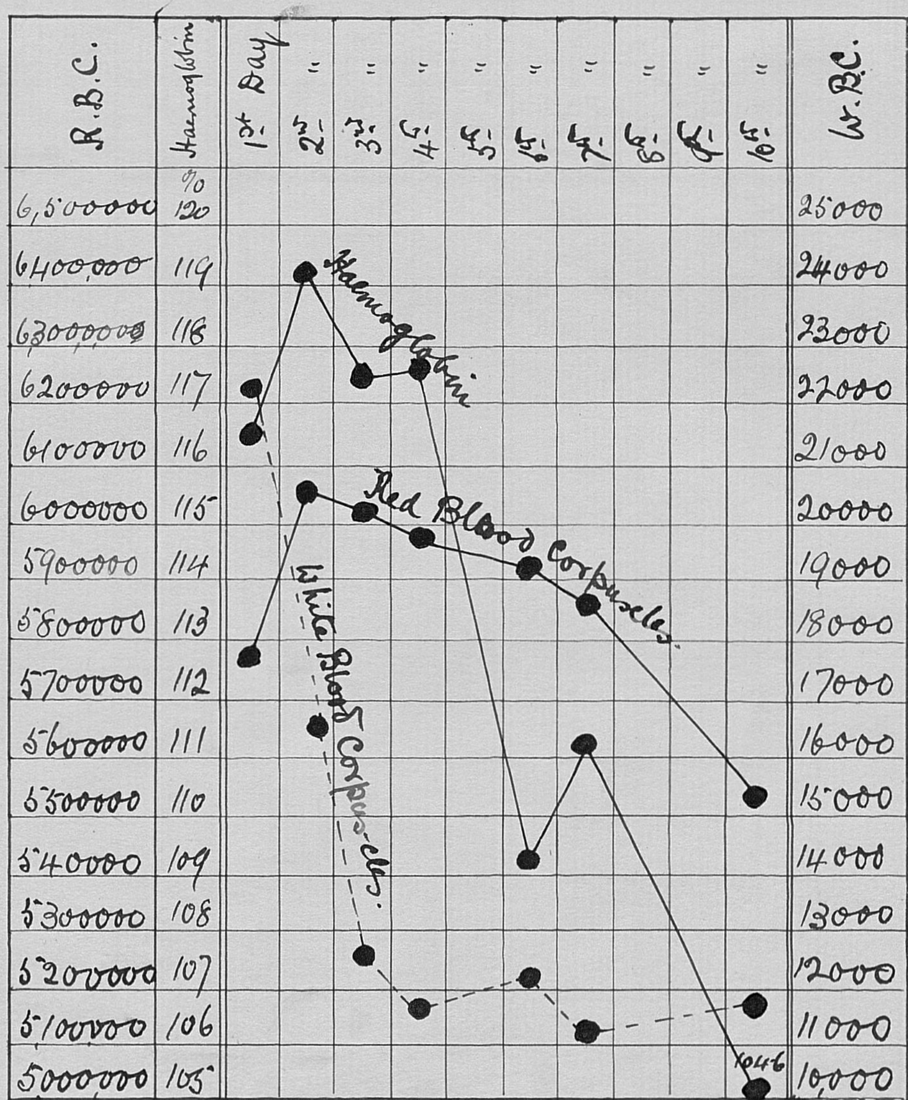
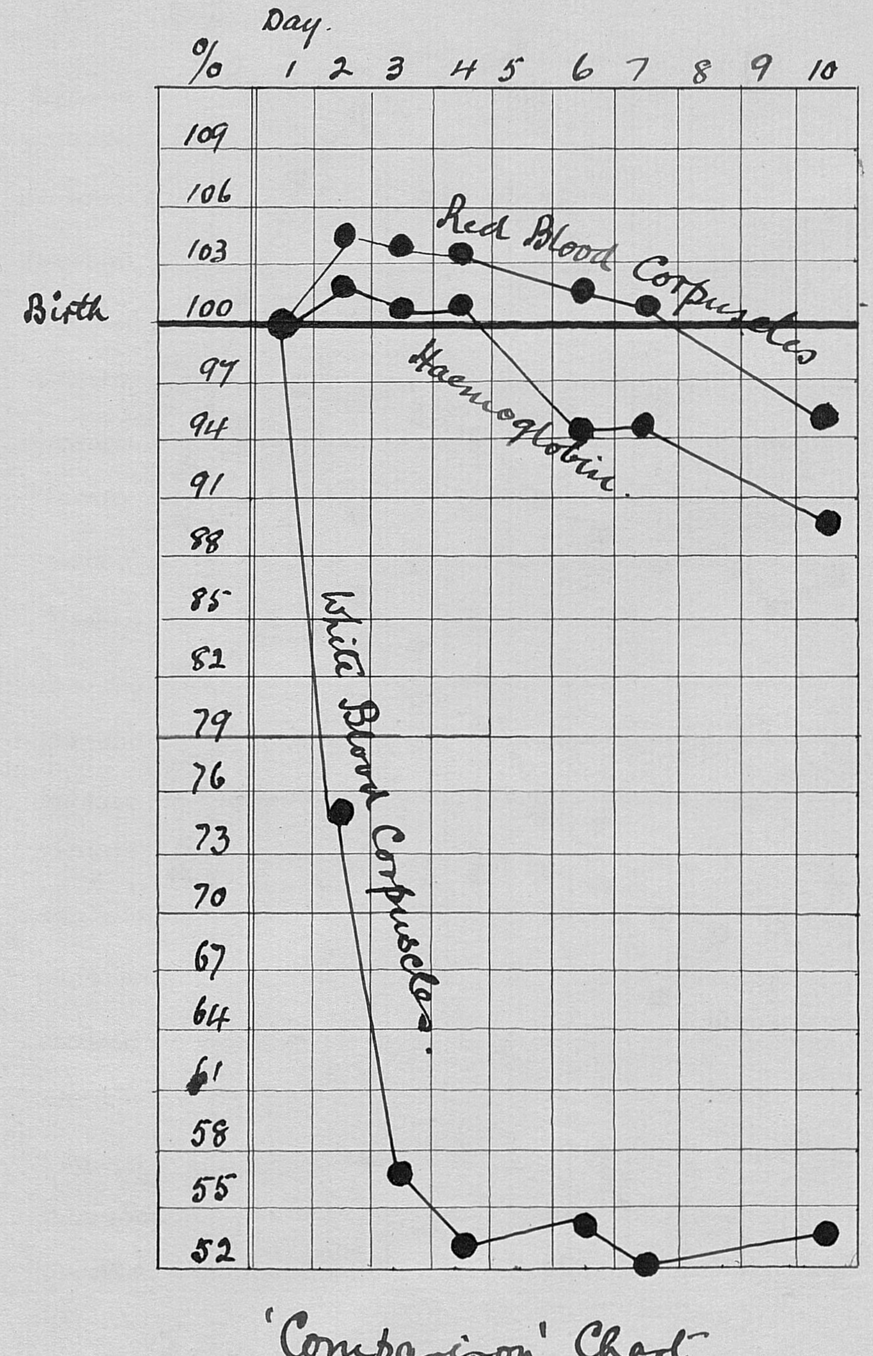
Chart I



Blood estimations in 18

new born Infants

Chart II



'Comparison' Chart

Calculated from Chart I; the 1st estimation in each series being reckoned as 100.

Chart III

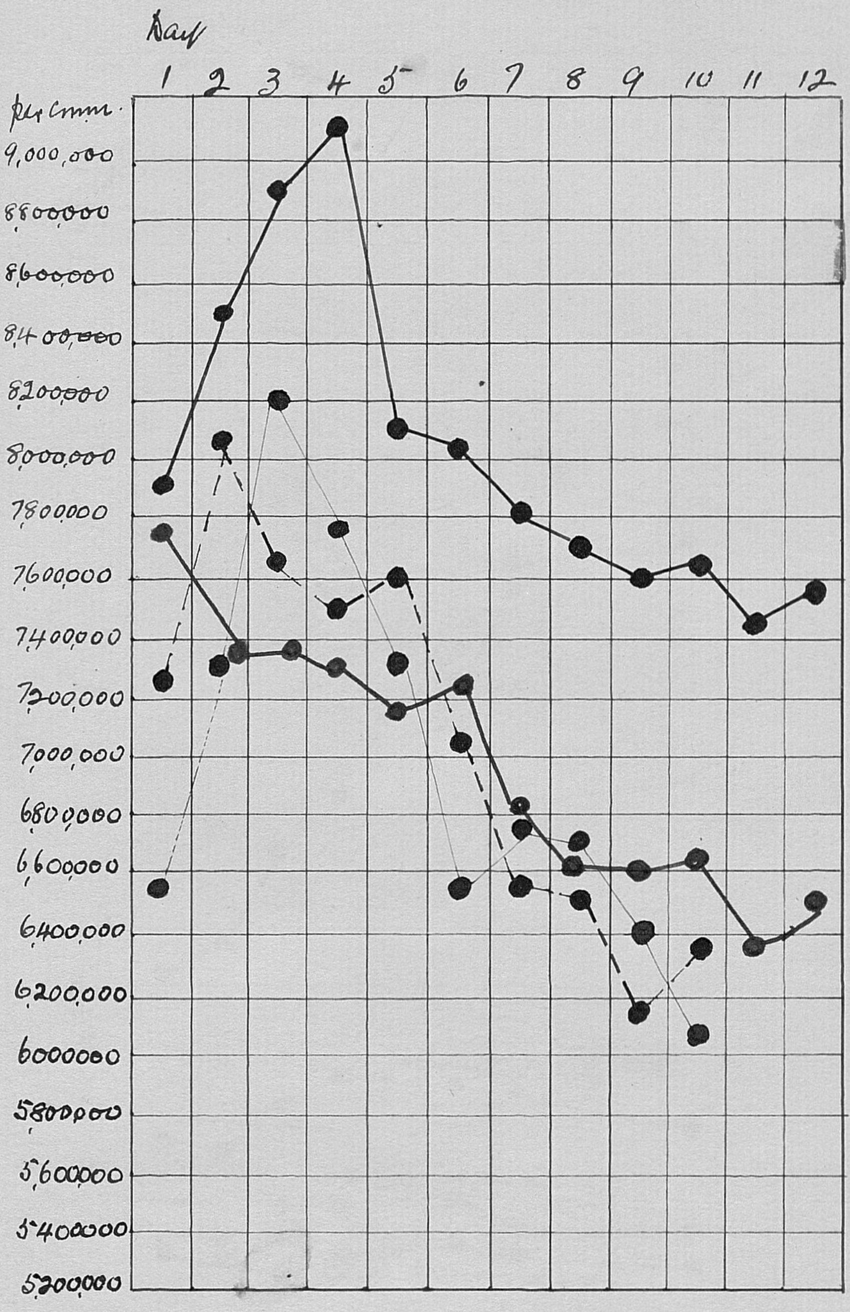
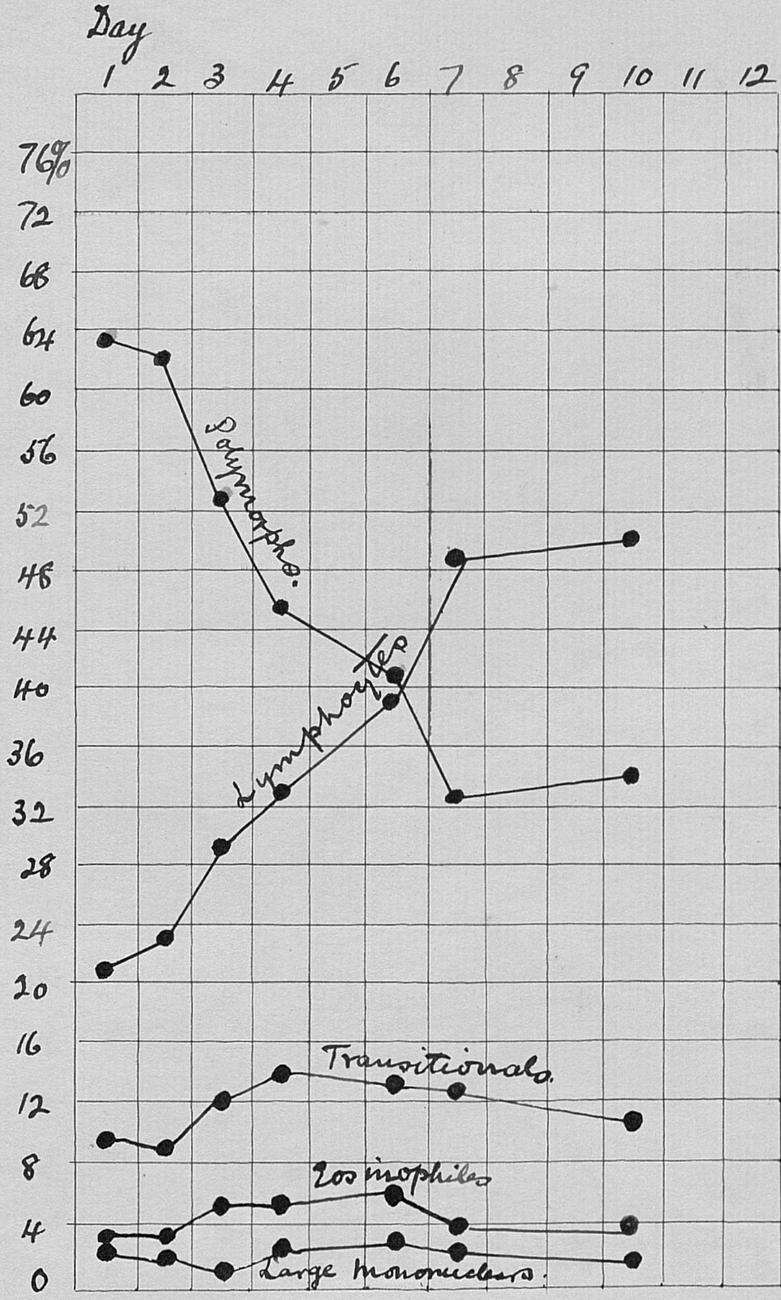


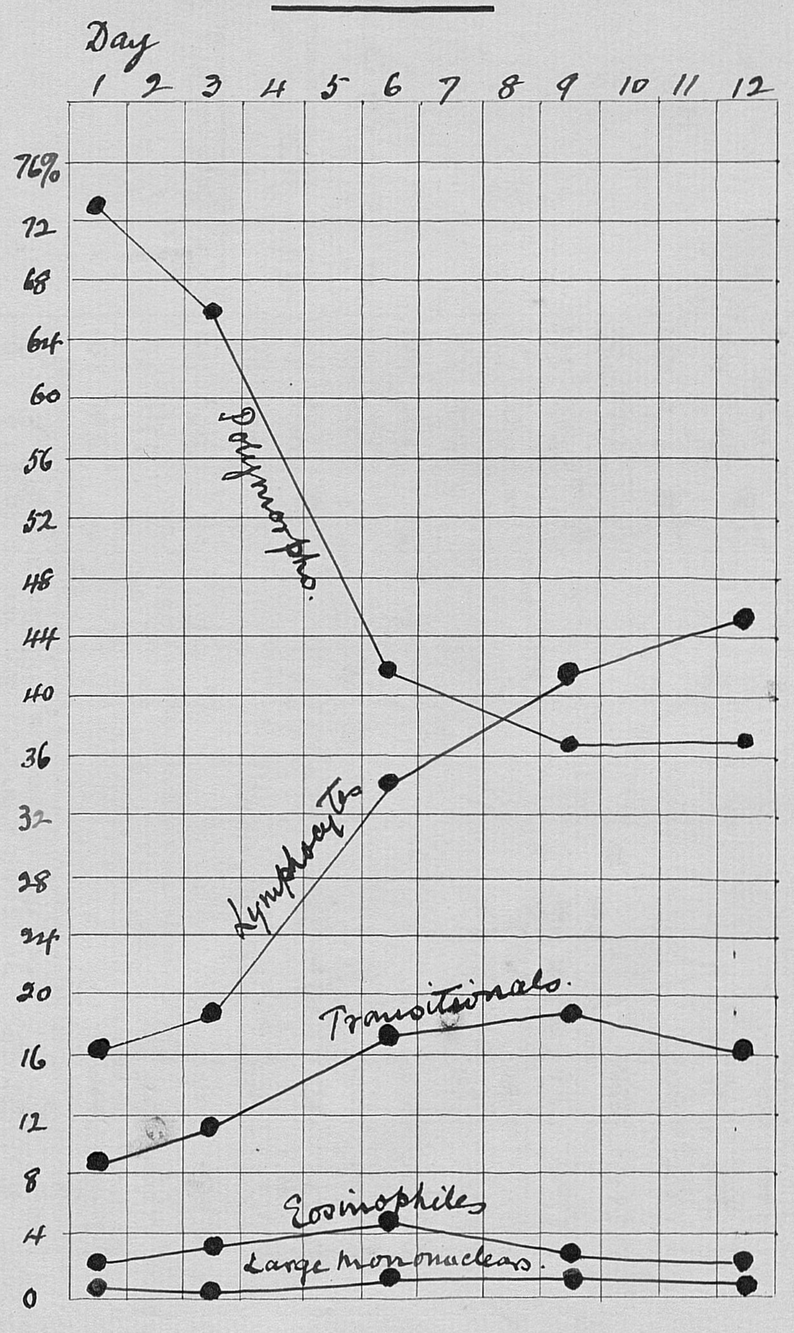
Chart III (after Schiff).
The three series of cases in which the cord was tied 10 minutes after birth are indicated in black ink, the 8 cases in which this took place immediately after birth, in red ink.

Chart IV



Differential Count, percentage values in 18 new born Infants.

Chart V



Differential count, percentage values in 5 new born infants.
(after Carstanjen).

Differential Count

absolute values per cumm

in 18 new born Infants.

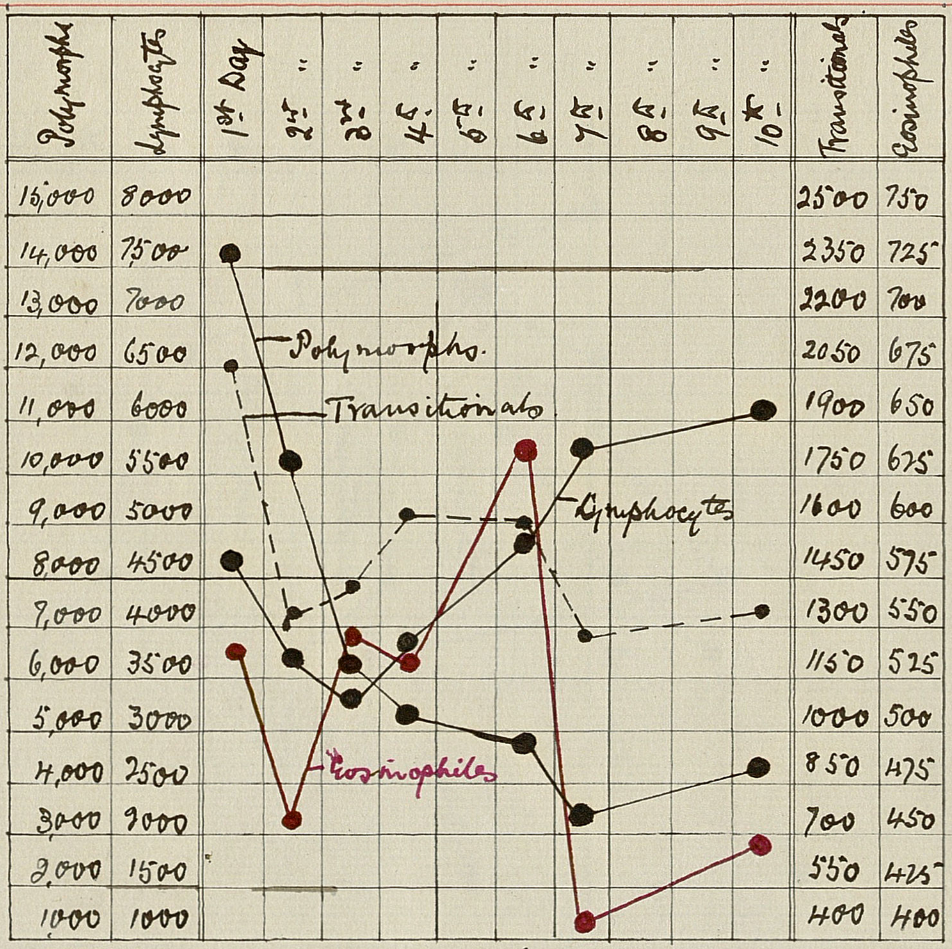
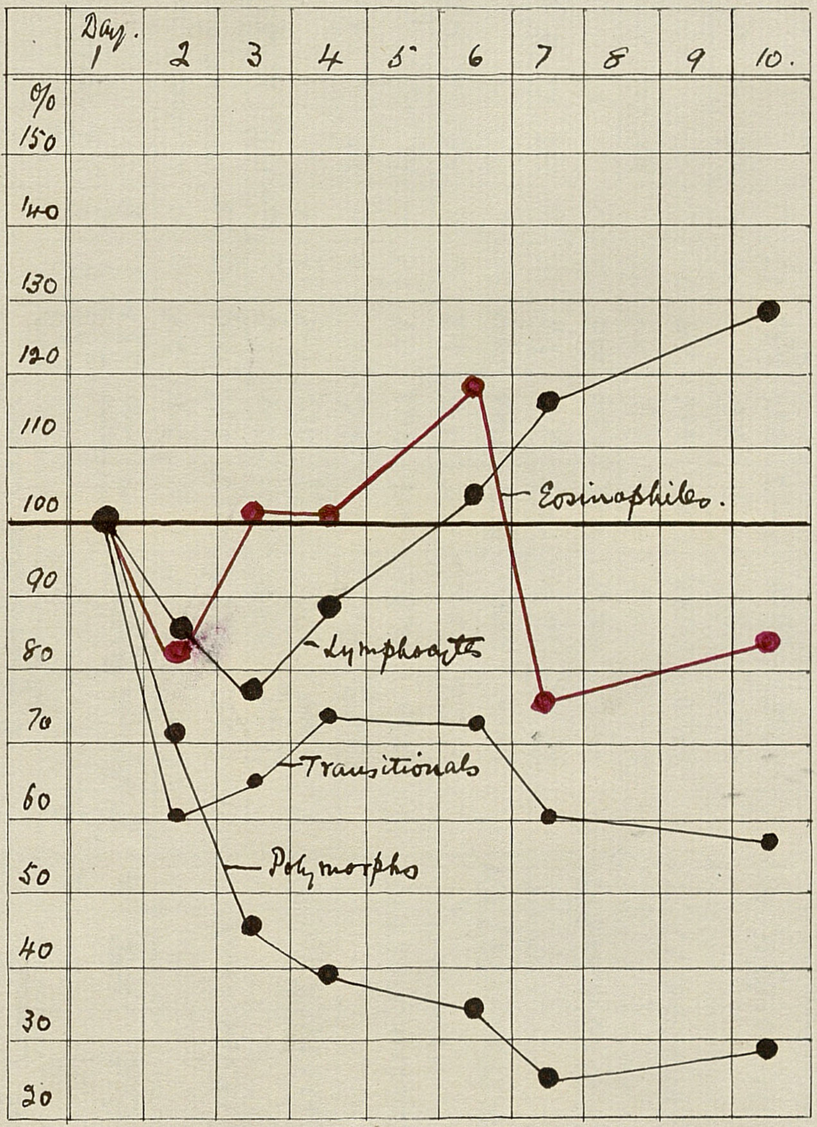


Chart VI

Chart VII



'Comparison' Chart

Absolute values of Differential Count. Count at birth in each series reckoned as 100. (from Chart VI)

Day.	Average Weight.	Blood Count: No. of cases.	R.B.C.	W.B.C.	%. Hb.	Differential Count: No. of Cases.	Polymorphs	Lymphocytes	Transit-ionals	Eosino-phils	Large mononucl. Lymphocytes	Mastzells	Myelocytes	Remarks.
1.	lbs. oz. 7. 5.	17.	5,791,764	22,098	116.5	17.	63.6% 14230	20.8 4652	9.2 2058	2.4 536	2.1 469	·4 89	·1 22	Nucleated reds occured in 16 cases.
2.	–	18.	6,062,500	16,510	119.1	18.	62.6% 10,188	23.3 3790	8.4 1366	2.8 455	1.9 309	·2 32	·05 1	N.R. in 15 cases.
3.	6.14.	18.	6,006,000	17561	117.5	13.	52.8% 6230	29.1 3435	12. 1416	4.6 542	1. 118	·2 23	– –	N.R. in 7 cases. Myelocytes ·001%.
4.	–	14.	5,988,500	11,757	117.8	8.	45.7% 5392	32.9 3884	13.8 1628	4.6 540	2.2 259	·3 35	– –	N.R. in 4 cases.
6.	7.1.	8.	5,906250	12,043	109.2	8.	40.2% 4910	39.9 4871	12.8 1562	5.2 634	2.5 305	·1 12	– –	N.R. in 5 cases.
7.	–	11.	5,864,454	11,177	111.1	10	32.6% 3393	48.8 5082	12.3 1280	3.9 406	2.1 218	·2 21	– –	N.R. in 5 cases.
10.	9th Day. 7.3.	18.	5,521,400	11,811	104.6	17.	33.9% 4209	49.3 6018	10.9 1352	3.6 446	1.9 235	·3 37	– –	N.R. in 6 cases.

Average total & differential Counts in 18 newborn Infants.

Examinations of the Maternal Blood in the 18 case.

Case	Before Delivery.				Leucocyte count in the Puerperium.									
	R.B.C.	% Hb	4-8 hours before Deliv. W.B.C	Immediately before Deliv. W.B.C.	Day 1	2	3	4	5	6	7	8	9	10
A.	4,610,000	60		17000	1	11700		11800			9,000			10,000
B.	4,500,000	88		16000		15000		10,300			11,800			10,600
C.	3,350,000	80	15,000	20,900		16800		13,400			10400			8,125
D.	3,750,000	80	17,000	15300		18400	19,300			11,250				8125
E.	3,960,000	80	19000	26,000		23,700	18,100			16,500				14,000
F.	4,100,000	74	8,400	17,000		8,750	14300			9,700				7,500
G.	4,600,000	76	16,875	23,400		15,000	21000	19600		15,000	11,000			13,700
H.	3,290,000	66		12500		10,900	10,900	10600			9,400			6,900
I.	3,980,000	90	12000	11,900		9,375	6,900							10,400

Examinations of the Maternal Blood (continued).

Case.	Before Delivery				Leucocyte Count in the Puerperium									
	R.B.C.	% of Hb.	48 hours before Deliv. W.B.C.	Immediately bef. Deliv. W.B.C.	Day 1	2	3	4	5	6	7	8	9	10
K.	4,200,000	78		15,000		11900	10600				13,000			6875
L.	4,890,000	70	21,900	21,900			22,800				10,000			11,900
M.	4,480,000	74	11,900	11,900			15,600				8,400			9000
N.	5,680,000	82		16,600			11,900				7,800			7500
O.	4,690,000	70	7,000	15,000		17,800		13000		13000				13,000
P.	5,050,000	70	19,400	16,700				13,000			8125			10,000
Q.	5,070,000	68		20,600				19,400			6900			9000
R.	4,800,000	72		21,200		19,300	18400	14,000			9,375			13000
S.	3,950,000	58	15000	21000		14,400	14,000							

Case A. Male 2nd. 1st Count 8 hours after birth. L.O.A.
Length 21 inches. Labour, laborious, 25 1/60 hours.

Day	Weight	Blood Count R.B.C.	W.B.C.	% Hb.	Differential Count Polymorphs.	Lymphocytes	Large mononucl. lymph.	Transit-ionals	Eosin-ophiles	Mastcells	Myelocytes	Remarks.
1	lbs. oz. 7. 12.	6,170,000	26,800	130	70.2% 18,813	12.8 3430	1.6 428	12.7 3403	1.1 294	1.1 294	.1 26	3 nucleated reds to 1000 W.B.C.
2	–	6,800,000	19,300	136	60.9 11753	20.6 3975	1.7 328	13.4 2593	2.2 424	.5 96	.1 19	5 " " Count on 3rd day. 7,160,000; 14,000; 130%.
4	3rd day 7. 10	7,200,000	11,800	128	34.5 4071	38.3 4523	7.7 908	13.5 1593	4.8 566	.5 63	– –	5 nucleated reds.
7	6th day 7.13.	5,810,000	11,500	120	35.5 4082	41. 4715	1.5 172	16.1 1851	3.3 379	.5 58	– –	7 nucleated reds.
10	9th day 7.14	5,470,000	10,000	112	42.6 4260	39.7 3970	2. 200	12. 1200	2.9 290	.6 60	– –	Several 'Shadow' cells.

Maternal Blood before delivery. R.B.C. 4,610,000; W.B.C. 17,000; Hb. 60%.

Case B. Female 1st. 1st Count 3 hours after birth. R.O.A.
Length 19 inches. Labour - Laborious. 36 25/60 hours.

Day	Weight	Blood Count R.B.C.	Blood Count W.B.C.	Blood Count % Hb.	Differential Count Polymorphs	Differential Count Lymphocytes	Differential Count Large mononuclear lymphocytes	Differential Count Transitionals	Differential Count Eosinophiles	Differential Count Mast cells	Differential Count Myelocytes	Remarks.
1.	lbs oz. 6.2.	6,350,000	34,700	126	75.9% 26,337	11.6 4025	1.8 624	8.2 2845	1.1 382	.7 242	.1 34	5 normoblasts to 1000 W.B.C.
2.	—	5,430,000	18750	128	63.3 11868	24.1 4518	3. 562	5.9 1106	3.2 600	.3 56	— —	1. free nucleus.
3.	6. -	5,675,000	15,600	120	67.6 10545	18.2 2839	1.2 187	10.4 1622	2. 312	.4 62	— —	1 normoblast
4.	-	5,640,000	12,500	118	58.6 7325	25.8 3225	1. 125	11.4 1425	2.1 262	.4 50	— —	Slight icterus evident
6.	6.7.	5,960,000	16,000	120	48.9 7824	33.3 5328	2.8 272	10.9 2032	3.7 336	.1 48	— —	1 normoblast. Shadow cells. Count on 7th day: 5,630,000; 15600; 110%.
10.	9th Day 6.8	5,630,000	14375	104	36.7 5254	42.1 6062	2. 288	16.5 2232	2.5 360	.8 115	— —	

Maternal Blood before delivery. R.B.C. 4,500,000, ; W.B.C. 16000; Hb. 88%.

Case C. Male 2nd. 1st count 1 hour after birth. R.O.A.

Length 20 inches. Labour normal $21\frac{40}{60}$ hours.

Day	Weight	Blood Count R.B.C.	W.B.C.	% Hb	Differential Count Polymorphs	Lymphocyt.	Large mononucl. lymph.	Transitional	Eosinophile	Mastcells	Myelocyte	Remarks.
	lbs. oz.				76.2%	14.	·2	7.1	1.	·5	·4	5 normoblasts to 1000
1.	6.15	5,600,000	19,400	118	14782	2716	38	1377	194	97	76	W.B.C.
					65.2	21.1	·5	8.9	4.1	—	—	2 normoblasts.
2.	—	6,140,000	13,700	134	8932	2890	68	1219	561	—	—	Count on 3rd Day. 6,530,000; 12,100; 136%.
	3rd Day				67.1	19.8	·4	10.2	2.	·1	—	6 normoblasts, two
4.	6.7	5,310,000	16,500	130	11071	3267	64	1683	330	16	—	free nuclei.
	6th Day.				33.8	41.7	1.5	17.8	4.8	·2	—	2 free nuclei.
7.	6.13	5,890,000	8,700	124	2904	3627	130	1548	417	17	—	
	9th Day				28.8	50.5	1.	14.2	5.	·5	—	
10.	6.14	5,780,000	11800	112	3398	5959	118	1675	590	59	—	

Maternal Blood before delivery. R.B.C. 3,350,000; W.B.C. 20,900; Hb. 80%.

Case D. Female 3rd. 1st Count 8 hours after birth. L.O.A.

Length, 21 inches. Labour normal $13\frac{50}{60}$ hours.

Day	Weight	Blood Count			Differential Count							Remarks.
		R.B.C.	W.B.C.	% Hb.	Polymorphs	Lymphocytes	Large mononuclear lymphocytes	Transitionals	Eosinophile	Mastcells	Myelocytes	
1	lbs. oz. 7.11	5,700,000	25,600	120	63.2% 16179	16.8 4300	2. 512	12. 3048	5.2 1331	·5 128	- -	2 normoblasts to 1000 W.B.C.
2	-	5,920,000	14,000	128	51.7 7238	28.5 3990	2.8 392	8. 1120	8. 1120	·5 70	- -	4 normoblasts; 1 megaloblast.
3	7.10	5,820,000	14,600	124	50.3 7343	21.8 3152	2. 292	12.7 1854	13.2 1927	- -	- -	
6	7.13	5,920,000	15,625	120	35.8 5584	42.5 6630	4.5 702	9.2 1435	8. 1248	- -	- -	
10	9th Day. 8.-	5,340,000	10,900	108	-	-	-	-	-	-	-	No differential Count made.

Maternal Blood before delivery. R.B.C. 3,750,000; W.B.C. 15,300; Hb. 80%

Case E. Female 1st. 1st Count 3 hours after birth. L.O.A.
Length, 19 inches. Labour normal $20\frac{35}{60}$ hours.

Day	Weight	Blood Count			Differential Count							Remarks.
		R.B.C.	W.B.C.	% Hb.	Polymorphs	Lymphocytes	Large mononucl. Lymphs.	Transitionals	Eosinophils	Mast cells	Myelocytes	
1	lbs. oz. 6. 8	5,510,000	22,600	106	71% 16046	15·1 3412	1·9 429	9· 2034	1·3 293	·2 45	— —	14 normoblasts, 1 double nucleus. to 1000 W.B.C.
2	—	6,800,000	11,250	110	59·2 6,630	28·5 3192	1·5 168	8·2 918	2· 224	·2 22	— —	3 free nuclei
3	6. 15	4,500,000	16,200	110	47·5 7,695	32·8 5313	·5 81	15·5 2511	3·3 534	·2 32	— —	1 normoblast Count on 4th day. 5,930,000; 13600; 114%.
6	6. 5	5,570,000	15,600	104	49·8 7768	33·3 5194	1·7 265	12·7 1981	2·1 327	·3 46	— —	
10	9th day. 6. 5	5,520,000	14375	98	42·9 6177	42·5 6120	2· 288	11·4 1641	1·2 172	— —	— —	

Maternal blood before delivery. R.B.C. 3,960,000.; W.B.C. 26000; Hb. 80%.

<u>Case F.</u> Female 1st. 1st Count 4 hours after birth. L.O.A.

Length 20 inches. Labour normal. $16\frac{36}{60}$ hours.

Day	Weight	Blood Count			Differential Count							Remarks.
		R.B.C.	W.B.C.	% Hb	Polymorphs.	Lymphocytes	Large mononuclear lymphocytes	Transitionals	Eosinophils	Mastcells	Myelocytes	
1.	lbs. oz. 7.-	6,240,000	16,200	132	74.1% 12,004	16. 2592	2.8 453 ~~891~~	5.5 891	.5 81	.3 48	.1 16	6 normoblasts to 1000 W.B.C
2.	–	7,470,000	14,400	136	65.2 9383	21.3 3067	2.5 360	7.2 1036	3.2 460	– –	– –	5 normoblasts
3.	6.12.	6,145,000	11500	124	44.9 5163	35.1 4036	3.2 364	13.7 1575	2.7 310	.4 46	– –	
6.	6.14	7,250,000	8125	112	37.8 3061	40.5 3280	4. 324	11.2 907	5.8 469	.6 48	– –	
10.	9th Day. 6.15	5,986,000	9300	116	35.7 3320	49.6 4612	1.7 158	11.1 1032	1.3 120	.4 37	– –	2 normoblasts

<u>Maternal Blood ~~before~~ Delivery</u>. R.B.C. 4,100,000; W.B.C. 12000; Hb. 74%.

Case 9. Male 1st. 1st Count 1 hour after birth. R.O.P. (long rotation).
Length 20 inches. Labour instrumental $17\frac{30}{60}$ hours. Low Forceps.

Day	Weight	Blood Count			Differential Count							Remarks.
		R.B.C.	W.B.C.	% Hb.	Polymorphs	Lymphocytes	Large mononucl. lymph.	Transitionals.	Eosinophiles	Mastcells	Myelocytes	
1	lbs. oz. 7. 3.	7,210,000	12,000	132	58·2 6984	24·2 2904	1·5 180	10·5 1260	2· 240	1·3 156	– –	23 normoblasts to 1000 W.B.C.
2	–	6,330,000	9680	128	72· 6984	12·8 1241	2·2 213	9·8 950	2· 194	·5 48	– –	7 normoblasts
3	6. 15	5,670,000	9375	130	46·5 4371	27·8 2343	1· 94	19·8 1861	3·4 319	1· 94	– –	5 normoblasts
4	–	6,280,000	12,500	130	36·2 4525	37·5 4687	2·2 275	17·5 2187	6· 750	·5 62	– –	Child getting very little milk from mother.
6	6. 7.	6,490,000	10,000	116	27· 2700	52·1 5210	1·2 120	15·5 1550	4·1 400	·1 10	– –	1 free nucleus Artificial feeding begun.
7	–	6,060,000	6400	116	25· 1600	62·7 4112	1·5 96	6·8 435	3·7 236	·1 6	– –	1 free nucleus.
10.	9th Day 6. 10	6,660,000	7,800	112	37·1 2893	50·9 3970	1·2 93	5·8 452	4·9 382	·1 8	– –	

Maternal Blood before Delivery. R.B.C. 4,600,000; W.B.C. 23,400; Hb. 76%

Case 4. Female 2nd. 1st Count 1 hour after birth. L.O.A.

Length 19 inches. Labour easy. 3 50/60 hours.

Day	Weight	Blood Count			Differential Count							Remarks.
		R.B.C.	W.B.C.	% Hb.	Polymorphs.	Lymphocytes	Large mononuclear lymph.	Transitional.	Eosinophile	Mastcells.	Myelocytes.	
1.	lbs. oz. 5,11	5,080,000	16800	128	47.7%. 8013	37.2 6249	3. 504	6.4 1075	4.8 806	.5 84	– –	4 normoblasts to 1000 leucocytes.
2.	–	6,015,000	14,000	122	58. 8120	28.3 3962	2.4 336	6.8 952	4.1 574	.4 56	– –	
3.	5.3.	7290000	5,900	125	37.2 2194	49.3 2908	3.1 177	7.1 418	2.9 171	.1 6	– –	2 normoblasts. Count on 4th Day. 5540000; 8300; 122%.
7.	6th Day 5.9.	5,[illegible]40,000	10600	116	20.7 2194	61.2 6497	4. 402	9.7 1028	4.2 445	– –	– –	1 free nucleus.
10.	9th Day 5.12	5,360,000	13750	110	30.2 4137	53.7 7356	1.5 205	11. 1507	3. 411	.4 54	– –	2 normoblasts.

Maternal Blood before delivery. R.B.C. 3290000 W.B.C. 12,500; Hb. 66%.

<u>Case I</u>. Female 2nd. 1st Count 1 hour after birth. R.O.P. (long rotation).
Length 20 inches. Labour easy $4\frac{15}{60}$ hours.

Day	Weight	Blood Count: R.B.C.	Blood Count: W.B.C.	Blood Count: % Hb	Differential Count: Polymorphs	Differential Count: Lymphocytes	Differential Count: Large mononucl. Lymphos.	Differential Count: Transitionals	Differential Count: Eosinophils	Differential Count: Mast cells	Differential Count: Myelocytes	Remarks.
1	lb. oz. 5. 13.	5,630,000	13125	120	43·9 % 5750	40·8 5344	1·7 222	8· 1048	5· 655	·1 13	·2 26	2 normoblasts to 1000 WBC.
2	–	6,220,000	15,000	126	72·3 10845	16·4 2460	1·9 285	8·6 1290	·4 60	·1 15	– –	3 normoblasts
3	5. 8	5,910,000	8125	114	46·9 3798	37·3 3021	1·4 113	8·5 688	5·1 413	·3 24	– –	1 normoblast Count on 4th day. 6,010,000; 9100; 117%.
7	6th Day. 5. 9	5,690,000	11200	110	16·5 1848	69·2 7750	1·7 190	10· 1120	2·5 280	·1 11	– –	
10	9th Day 5. 11	5,650,000	8700	114	24· 2088	60·5 5263	·9 78	11·8 1026	2·8 243	– –	– –	

<u>Maternal Blood before Delivery</u>. R.B.C. 3,980,000; W.B.C. 11,900; Hb. 90%.

Case K. Female 3rd. 1st Count 3 hours after birth. Breech L.S.A.

Length 20 inches. Labour normal 7 hours.

Day	Weight	Blood Count R.B.C.	Blood Count W.B.C.	Blood Count % Hb	Differential Count Polymorphs.	Lymphocytes	Large mononucl. lymphs.	Transitionals	Eosinophiles	Mast-cells	Myelocytes	Remarks.
1.	lbs.oz. 7.5	6,100,000	24,900	110	62.8% 15,637	18.8 4681	2.2 547	11.5 2863	1.5 373	·2 49	– –	3 normoblasts to 1000 W.B.C.
2.	–	6,900,000	18750.	126	75. 14025	12.5 2337	1. 187	9.6 1795	1.2 224	·2 37	– –	2 normoblasts.
3.	6.11	7,360,000	13,100	114	59. 7729	22.5 2947	4.5 589	12.8 1676	1. 131	·1 13	– –	Count on 4th Day. 6,810,000; 13900; 118%.
7.	6th Day 6.11	6,800,000	11,300	114	32.5 3672	45. 5085	3.2 361	14.5 1638	4.2 474	·5 56	– –	
10.	9th Day. 6.7	6,100,000	11600	106	42.5 4930	40.5 4698	1.2 139	11.2 1299	3.2 371	·2 23	– –	

<u>Maternal Blood before delivery.</u> R.B.C. 4,200,000; W.B.C. 15,000; Hb. 78%.

Case L. Male 1st. First count 3 hours after birth. L.O.A.

Length 19¼ inches. Labour normal. 14 15/60 hours.

Day	Weight	Blood Count			Differential Count							Remarks.
		R.B.C.	W.B.C.	% Hb.	Polymorphs.	Lymphocyt.	Large mononucl. Lymphs.	Transit-ionals	Eosino-philes	Mast cells	Myelocytes	
1.	lbs. oz. 6.3.	6,520,000	17,800	116	62.2 % 11,071	26.5 4717	1.5 267	6.8 1210	2.8 498	·2 35	— —	No normoblasts.
2.	–	6,600,000	12500	124	51.1 6307	35.1 4387	2.5 312	9.5 1187	1.2 150	·5 62	— —	
3.	5.15.	5,970,000	12,500	120	40.5 5625	35.5 4437	3. 375	13.5 1687	7.2 900	·2 25	— —	Count on 4th day. 5,620,000; 10,300; 116%
7.	6th day. 6.3.	5,870,000	11,250	108	36. 4032	40.8 4569	2.5 280	14. 1568	6.5 720	— —	— —	
10.	9th Day. 6.11	5,570,000	13,700	94	27.3 3740	54.3 7398	1.2 164	10.2 1397	6.7 917	·2 27	— —	

Maternal blood before delivery. R.B.C. 4,890,000; W.B.C. 21900; Hb. 70%.

Case M. Male 1st. 1st Count 3 hours after birth. L.O.A.
Length 21 inches. Labour normal $12\frac{30}{60}$ hours.

Day	Weight	Blood Count			Differential Count							Remarks
		R.B.C.	W.B.C.	% Hb	Polymorpho.	Lymphocy.	Large mononucl. lymphs.	Transit-ionals	Eosinophile	Mastcells	Myelocytes	
1	lbs. oz. 7.12	5,130,000	31,250	100	60.8% 18,969	22· 6864	1.6 499	10.6 3307	1.1 343	·6 187	·3 93	24 normoblasts, 2 microblasts. to 1000 W.B.C.
2	–	4,640,000	13,750	98	60.2% 8247	23.8 3260	·7 951	11.8 1616	3.1 411	·2 27	– –	2 normoblasts
3	7. 3	4,360,000	15,000	96	60.7% 9105	21.8 3270	3· 450	10.2 1530	4· 600	·2 30	– –	
7	6th Day 7. 3.	4,760,000	13,400	92	45· 6030	37.2 4984	2· 268	12.5 1675	3· 402	·2 27	– –	
10	9th Day. 7. 5	5,140,000	17,500	94	40.1 7017	50.5 8837	1.8 315	6· 1050	1.2 210	·5 87	– –	

Maternal Blood before delivery. R.B.C. 4,480,000; W.B.C. 11,900; Hb 74%.

Case N. Male 2nd 1st Count 1 hour after birth. Transverse R.A.P.

Length 21 inches. Labour - Turning - 16 30/60 hours. Child required artificial respiration for 1/2 hour.

Day	Weight	Blood Count			Differential Count							Remarks.
		R.B.C.	W.B.C.	% Hb.	Polymorphs.	Lymphocyt.	Large mononucl. lymphoc.	Transitional.	Eosinophile.	Mast cells.	Myelocyte.	
1	lbs. oz. 7.13.	5,240,000	36900	108	53. % 19,610	19.2 7030	6.5 2405	18.2 6734	2.5 925	·1 37	·8 296	98 normoblasts, 2 megaloblasts, 9 microblasts; 3 free nuclei. to 100 W.B.C.
2	7.-	5,650,000	16,000	106	58.5 9360	28.1 4488	3.8 608	5.4 864	2.5 400	– –	·3 48	12 normoblasts, 2 free nuclei.
3	7.	5,600,000	11,900	110	53.6 6378	27. 3213	3.8 452	8.6 1023	5. 595	– –	·1 12	18 normoblasts Count on 4th Day: 5,790,000; W.B.C. 12000; Hb. 110%
6	7.3.	5,720,000	11,000	100	54. 5400	25.1 2500	1.5 150	12.8 1280	5.5 550	·2 20	– –	6 normoblasts 4 free nuclei
10	9th Day. 7.12	5,580,000	12,500	98	50.6 6,325	30.5 3812	6.5 832	8. 1000	3.8 475	·5 62	– –	1 normoblast.

Maternal blood before Delivery. R.B.C. 5,680,000; W.B.C. 15600; Hb. 82%.

Case, O. Male 1st. 1st count 12 hours after birth. R.O.P. (persistent).
Length 20 inches. Labour instrumental. 15 30/60 hours.
'Low' Forceps.

Day	Weight	Blood Count — R.B.C.	W.B.C.	% Hb.	Differential Count — Polymorphs.	Lymphocyt	Large mononucl. lymph.	Transit-ionals	Eosin-ophils	Mast cells.	Myelocytes.	Remarks.
1	lbs. oz. 7.11	5,270,000	23,600	104	70.2% 16567	14.5 3422	2.8 660	10.2 2407	1.8 424	·2 20	– –	1 normoblast, 1 microcyte to 1000 W.B.C.
2	–	5,280,000	13,400	108	64.4 8629	23. 3082	1.8 241	6.6 884	3.8 509	·4 53	– .	Count on 3rd day. 5,960,000; 10600; 110%.
4	3rd Day 6.15	5,420,000	9,700	98	38.1 3695	32.1 3104	1.2 116	18.5 1794	10. 970	·2 19	– –	
6	7.4	5,310,000	8,000	100	33.7 2696	49.6 3968	3. 240	8.7 696	4.4 352	·3 24	– –	2 free nuclei.
10	9th Day. 7.10	5,370,000	12,500	90	34.4 4,300	44.4 5550	2.3 287	16.2 2025	2.3 287	·3 37	– –	

Maternal Blood before delivery. R.B.C. 4,690,000; W.B.C. 15000; Hb. 70%.

Case P. Male 2nd 1st Count 1 hour after birth. L.O.A.

Length 21 inches. Labour easy, 5 50/60 hours.

Day	Weight	Blood Count R.B.C.	Blood Count W.B.C.	% Hb.	Differential Count Polymorphs	Lymphocytes	Large mononuclear lymphocytes	Transitionals	Eosinophiles	Mast cells	Myelocytes	Remarks.
1	lbs. oz. 9.3	5,730,000	14300	118	59.5% 8508	35.3 3617	2.2 314	5.2 743	4.4 629	·3 42	— —	28 normoblasts, 1 megaloblast. Poikilocytosis
2	—	6,080,000	16,900	114	45.7 7723	36.5 6168	2.5 422	8. 1352	6.9 1166	·2 34	— —	2 normoblasts Count on 3rd day. 6,375,000; 12000; 120%.
4	3rd day. 8.7.	5,760,000	10,600	110	37.7 3996	38.1 4038	2.2 233	15.9 1685	5.6 593	·2 21	— —	3 normoblasts.
7	6th day 8.10	5,439,000	10,000	106	34.1 3410	49.2 4920	1.5 150	11.2 1120	3.5 350	·4 40	— —	2 free nuclei
10	9th day 8.14	5,130,000	10,000	100	25.8 2580	55.4 5540	2.7 270	10.6 1060	4.9 490	·6 60	— —	

Maternal Blood before delivery. R.B.C. 5,050,000; W.B.C. 16700; Hb. 70%.

<u>Case Q</u>. Male 1st. 1st Count 1 hour after birth. R.O.P. (long rotation).

Length 21 inches. Labour normal, 12 40/60 hours.

Day	Weight	Blood Count			Differential Count							Remarks.
		R.B.C.	W.B.C.	% Hb	Polymorph	Lymphocyt	Large mononucl. lymphocyt.	Transit-ionals	Eosin-ophils	Mast cells	Myelocyt	
	lbs. oz.				64.2%	20.8	1.8	8.5	3.7	·2	·8	106 normoblasts, 1 megaloblast, 3 microblasts
1	9. -	5,040,000	17,700	110	11,363	3681	318	1504	654	35	141	Shadow cells, 4 mitosis.
					61.7	23.6	2.	7.8	·4	·2	–	45 normoblasts. Count on 3rd day.
2	–	5,800,000	19,000	126	11,722	4484	380	1482	76	38	–	6,210,000; 14,600; 116%.
	3rd day				47.	34.5	·5	15.2	·3	·2	–	22 normoblasts, 2
4	8. 13.	5,970,000	10,600	118	4982	3657	53	1611	31	21	–	free nuclei
	6th day											
7	8. 15	–	–	–	–	–	–	–	–	–	–	No count made.
	9th Day.				35.4	48.9	1.3	11.6	2.2	–	–	4 free nuclei
10	9. -	5,100,000	10,000	114	3540	4890	130	1160	220	–	–	

<u>Maternal blood before delivery</u>. R.B.C. 5,070,000; W.B.C. 20,700; Hb. 68%.

<u>Case R.</u> Female 1st. 1st count 24 hours after birth. R.O.P. (long rotation). Length 22 inches. Labour Instrumental 22 35/60 hours. Very long 2nd stage. High forceps.

Day	Weight	Blood Count			Differential Count							Remarks.
		R.B.C.	W.B.C.	% Hb	Polymorphs	Lymphocyt.	Large mononucl. Lymph.	Transit-ionals	Eosin-ophiles	Mast cells	Myelocytes	
2	lbs. oz. 1st day. 8.9.	5,490,000	29,000	108	75.4% 21,866	16.6 4814	2.2 638	4.6 1334	.8 232	.1 29	– –	3 normoblasts. Child fed before first count.
3	8.6	6,230,000	16,000	114	62.8 10,048	25. 4000	2.2 352	8.2 1312	1.8 288	– –	– –	
4	–	6,560,000	12,500	114	46.2 5775	36.6 4575	2.8 350	8.1 1012	6.1 762	.2 25	– –	Child seems to get very little nourishment.
7	6th day. 8.6	6,640,000	13,000	106	49.5 6435	32.5 4225	3. 390	10.5 1365	4.2 546	.2 26	– –	Being fed artificially.
10	9th Day. 8.9	5,410,000	11,000	106	34.5 3795	52.5 5775	2.2 242	6.2 682	4.5 495	– –	– –	

<u>Maternal Blood before delivery.</u> R.B.C. 4,800,000; W.B.C. 21200; Hb. 72%.

Case 8. Male, 1st. 1st Count 1 hour after birth. L.O.A.

Length 21 inches. Labour ~~normal~~ Instrumental, 15 10/60 hours. Long 2nd Stage due to premature rupture of membranes, 'low' forceps.

Day	Weight	Blood Count			Differential Count							Remarks.
		R.B.C.	W.B.C.	% Hb.	Polymorphs	Lymphocytes	Large mononucl. lymph.	Transitionals	Eosinophiles	Mastcells	Myelocytes	
1	lbs. oz. 7. 6	5,940,000	22,000	102	69.5% 15,290	18. 3960	·5 110	9 1980	1. 220	·2 44	– –	18 normoblasts to 1000 W.B.C.
2	–	5,560,000	27,800	96	67.5% 18765	19. 5282	·7 139	11.2 2502	1.2 278	·2 55	– –	2 normoblasts.
3	6.12	5,340,000	13,000	100	56.8 7384	24.2 3146	1. 130	9. 1170	9. 1170	– –	– –	1 " .
6	6.13	5,030,000	12,000	102	33.2 4249	33.5 4288	1. 128	22.7 2905	9.2 1177	·1 13	– –	2 free nuclei.
10	9th Day 7. –	4,590,000	12,800	96	31.7 3804	47.5 5700	1. 120	11.5 1380	7.9 948	·2 24	– –	2 normoblasts.

Maternal Blood before delivery. R.B.C. 3,950,000; W.B.C. 21,000; Hb 58%.